

Errata

Title & Document Type: 313A Tracking Oscillator Operating and Service Manual

Manual Part Number: 00313-90002

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This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, life sciences, and chemical analysis businesses are now part of Agilent Technologies. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A. We have made no changes to this manual copy.

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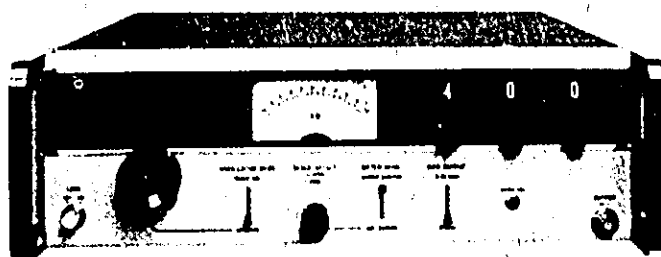
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TRACKING OSCILLATOR

313A



HEWLETT  PACKARD



OPERATING AND SERVICE MANUAL

MODEL 313A

TRACKING OSCILLATOR

Serial Prefixed: 0962A

Notice

Appendix C, Manual Backdating Change adapts this manual to the following instruments: Serial No. 0962A00500 and below.

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excess moisture.

Manual Part No. 00313-90002

Microfiche Part No. 00313-90052

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P.O. Box, 301, Loveland, Colorado 80537 U.S.A.

Printed: June 1976

CERTIFICATION

Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except that in the case of certain components, if any, listed in Section I of this operating manual, the warranty shall be for the specified period. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the proper preventive maintenance procedures as listed in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. **NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.**

If this product is sold as part of a Hewlett-Packard integrated instrument system, the above warranty shall not be applicable, and this product shall be covered only by the system warranty.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

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SECTION I GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Hewlett-Packard Model 313A Tracking Oscillator complements the Hewlett-Packard Model 312A Wave Analyzer in making system gain measurements, distortion checks, etc. The 313A has two modes of operation, a TRACK 312A mode and an INTERNAL mode. When used in the TRACK 312A mode, the 313A utilizes the 30 MHz Crystal Oscillator output and the Local Oscillator output of the 312A to provide output levels from -99.9 dB to +10 dBm in 0.1 dB steps and a frequency range between 10 kHz and 18 MHz. (10 kHz-22 MHz with H01-312A). When used in the INTERNAL mode, the 313A utilizes an internal Local Oscillator and 30 MHz Crystal Oscillator to generate output levels from -99.9 dB to +10 dBm in 0.1 dB steps and a frequency range between 10 kHz and 22 MHz. Table 1-1 lists the specifications for the 313A.

1-3. A special feature of the 313A is the Meter Expand function. When used in the Meter Expand function, the RECORDER OUTPUT of the 312 can be displayed on the 313A meter as 2 dB full scale. Any 2 dB between -7 dB and +3 dB on the 312 meter can be selected with 0.02 dB resolution on the 313A meter. The 313A also provides a RECORDER OUTPUT so that external instruments can be used to monitor the output.

1-4. ACCESSORY EQUIPMENT SUPPLIED.

1-5. The accessory equipment supplied with the 313A is listed in Table 1-2.

Table 1-2. Accessory Equipment Supplied

-hp- Part No	Quantity	Description
8120-0078	1	Power Cord
00313-84411	1	Kit: Accessory
Kit Consists Of		
11086A	3	Accessory Cables, 24"
5060-4940	1	15 pin Extender Board

1-6. ACCESSORY EQUIPMENT AVAILABLE.

1-7. The Model 313A is initially shipped as a bench instrument. A rack mount kit, -hp- Part No. 5060-8740 (Option 908), is available to convert to a rack mounted instrument.

1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual or backdating information in the back of this manual will define differences between your instrument and the Model 313A described in this manual. If the serial number is preceded by a letter, the instrument was manufactured outside the United States.

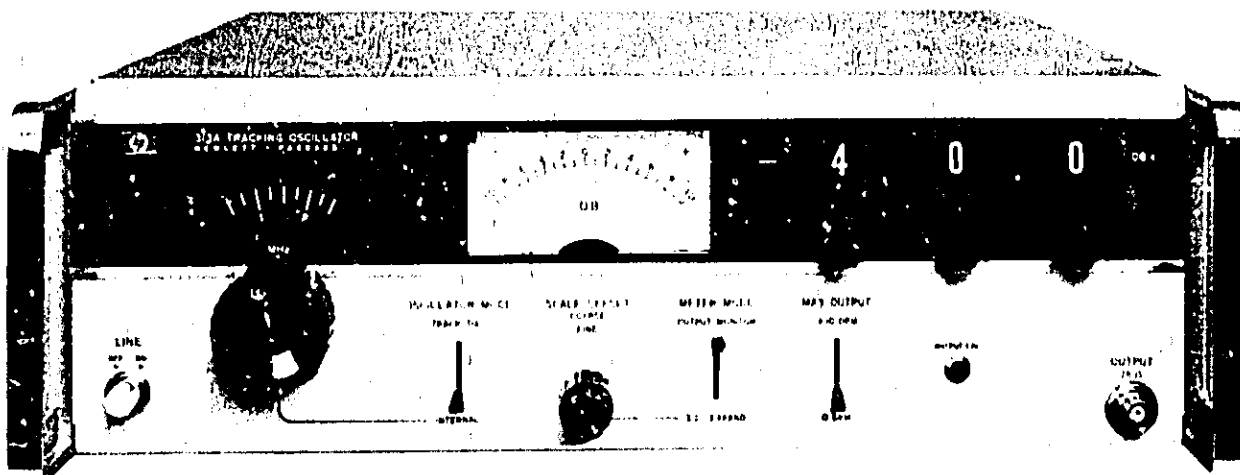


Figure 1-1. Model 313A Tracking Oscillator

Table 1-1. Specifications

FREQUENCY RANGE:

As tracking oscillator: Same as 312A (10 kHz to 18 MHz) or H01-312A and H05-312A (10 kHz to 22 MHz).

As signal source: 10 kHz to 22 MHz in one band, continuous tuning.

FREQUENCY ACCURACY:

As tracking oscillator: 35 Hz \pm 4 Hz above 312A tuning.

As signal source: $\pm 1\%$ of maximum dial setting from 10 kHz to 2 MHz $\pm 3\%$ of maximum dial setting from 2 to 8 MHz; $\pm 5\%$ of maximum dial setting from 8 to 22 MHz.

FREQUENCY STABILITY:

As tracking oscillator: Same as 312A time base.

As signal source: Short term (5 min.) drift < 1 kHz in stable environment after warmup.

FREQUENCY RESPONSE: ± 0.1 dB 10 kHz to 22 MHz.

AMPLITUDE STABILITY: ± 0.1 dB for 90 days (0 to 55°C).

METER MODE:

312A Expand: Meter expands any 2 dB range of 312A meter indication from -7 to +3 dB using 312A recorder output. Meter range, -1 to +1 dB; tracking error ± 0.05 dB over full 2 dB range.

MAXIMUM OUTPUT: 0 or +10 dBm ± 0.1 dB, selectable at front panel.

OUTPUT ATTENUATOR: Three-section attenuator provides 0 to 99.9 dB attenuation in 0.1 dB steps.

ATTENUATOR ACCURACY:

0.9 dB section (0.1 dB steps): ± 0.02 dB.

9 dB section (1 dB steps): ± 0.2 dB.

90 dB section (10 dB steps): ± 0.1 dB to 50 dB, ± 0.2 dB to 90 dB.

RECORDER OUTPUT: 0.3 V for full scale. Output impedance 1 K ohm.

OUTPUT IMPEDANCE: 75 Ω unbalanced (50 Ω optional).

OUTPUT CONNECTOR: BNC female.

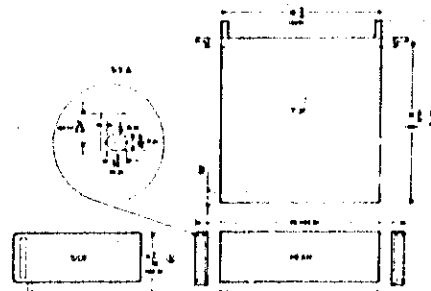
HARMONIC DISTORTION: More than 34 dB below fundamental.

NON-HARMONIC DISTORTION:

As tracking oscillator: More than 40 dB below fundamental.

As signal source: More than 50 dB below fundamental.

POWER: 115 or 230 V $\pm 10\%$, 50 to 66 Hz, 30 W maximum.

DIMENSIONS:

NOTES:
1. The unit is designed to operate on 115 or 230 V AC.
2. The unit is designed to operate on 50 or 60 Hz AC.
3. The unit is designed to operate on 115 or 230 V AC, 50 or 60 Hz, 30 W maximum.

SECTION II INSTALLATION

2-1. INTRODUCTION

2-2. This section contains instructions for installing and interfacing the Model 313A Tracking Oscillator. Included are initial inspection procedures, power and grounding requirements, environmental requirements, installation instructions, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of marks or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Check for supplied accessories (Paragraph 1-4) and test the electrical performance using the Performance Tests given in Section V. If there is damage or deficiency, see the warranty in the front of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Model 313A will operate from either 115 or 230 Vac, 50 - 66 Hz. The instrument can be easily converted from 115 or 230 volt operation by changing the position of the slide switch located on the rear panel, so that the designation appearing on the switch matches the nominal voltage of the power source. A 0.3 ampere, slow-blow fuse is used for 115 volt and 0.15 ampere, slow-blow for 230 volt.



BEFORE APPLYING PRIMARY POWER TO THE 313A, BE SURE IT IS SET FOR THE PROPER LINE VOLTAGE AND IS PROPERLY FUSED.

2-7. POWER CORDS.

2-8. Figure 2-1 illustrates the standard power plug configurations that are used throughout the United States and in other countries. The -hp- part number directly below each drawing is the part number for a 313A power cord equipped with a power plug of that configuration. If the appropriate power cord is not included with the instrument, notify the nearest -hp-

Sales and Service Office and a replacement cord will be provided.

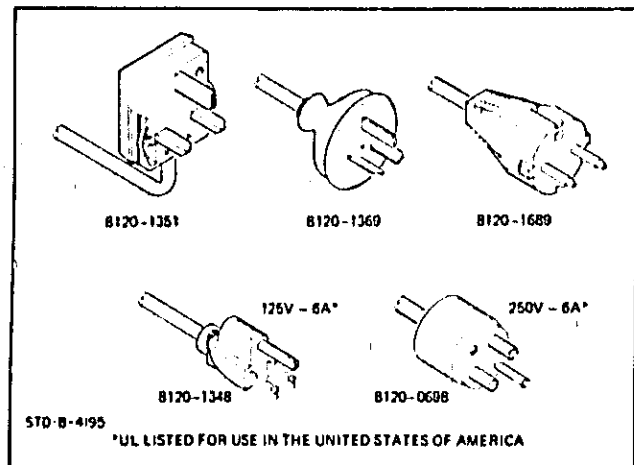


Figure 2-1. Power Cords.

2-9. GROUNDING REQUIREMENTS.

2-10. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 313A is equipped with a three-conductor power cord which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power plug is the ground connection.

2-11. INSTALLATION.

2-12. The -hp- Model 313A is fully transistorized; therefore no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F).

2-13. RACK/BENCH INSTALLATION.

2-14. The Model 313A is initially shipped as a bench-type instrument with plastic feet and a tilt stand in place. Conversion to a rack-mounted instrument can be accomplished by using a rack mounting kit, Option 908, (-hp- Part No. 5060-8740) which must be ordered separately.

2-15. REPACKAGING FOR SHIPMENT.

2-16. The following is a general guide for repackaging for shipment. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

- a. Place instrument in original container if available. If original container is not avail-

able, a suitable one can be purchased from your nearest -hp- Sales and Service Office.

If original container is not used,

- b. Wrap instrument in heavy paper or plastic before placing in an inner container.
- c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.
- d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.
- e. Mark shipping container with "Delicate Instrument," "Fragile" etc.

OPERATION

SECTION III OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Model 313A Tracking Oscillator has an INTERNAL mode of operation and a TRACK 312A mode of operation. In the INTERNAL mode of operation, the 313A Local Oscillator and Crystal Oscillator are used to generate output frequencies between 10 kHz and 22 MHz at levels between -99.9 dB and +10 dBm. In the TRACK 312A mode, the 313A Local Oscillator and Crystal Oscillator are disabled and these signals are replaced by inputs from the Model 312A. When the 312A signals are used, the 313A output level is still variable between -99.9 dB and +10 dBm but the frequency range is only from 10 kHz to 18 MHz. (10 kHz-22 MHz when used with H01-312A or H05-312A.)

3-3. When the METER MODE switch is in the OUTPUT MONITOR position, the 313A front panel meter is used to indicate that the output of the 313A is calibrated, or it can be used in the 312A EXPAND position to display the 312A RECORDER OUTPUT on an expanded scale for increased resolution.

3-4. CONTROLS AND INDICATORS.

3-5. Figure 3-1 and Table 3-1 identifies and describes the function of all front and rear panel controls, connectors and indicators on the 313A.

3-6. METER MECHANICAL ZERO.

3-7. The meter should be mechanically zeroed before the 313A is used. To do this, insert some pointed object such as a toothpick or ball point pen into the recess on the adjustment wheel and adjust the meter until the needle rests directly over the -1.0 division marker.

3-8. TURN-ON PROCEDURE.

- a. Before connecting the 313A to a power source, insure that the 115/230 Vac slide switch on the rear panel is in the appropriate position.
- b. Connect the 313A to the ac power source using the power cable supplied with the instrument.



WHEN THE MODEL 313A IS CONNECTED TO A POWER SOURCE, POWER IS AVAILABLE AT THE AUXILIARY POWER JACK ON THE REAR PANEL EVEN WHEN THE MODEL 313A IS TURNED OFF.

- c. Depress the LINE ON/OFF switch and note that the ON/OFF indicator lamp illuminates.

3-9. OPERATION.

3-10. To operate the 313A in the INTERNAL mode, proceed as follows:

- a. Place the OSCILLATOR MODE switch in the INTERNAL position. This energizes the internal Local Oscillator and Crystal Oscillator.
- b. Connect a 75 ohm load to the output jack.
- c. Place the METER MODE switch in the OUTPUT MONITOR position and note that the meter reads full scale on the CAL mark.

NOTE

A warmup time of 30 minutes should be allowed for the 313A circuits to stabilize. When the instrument is first turned on, the meter will read slightly above the CAL mark but will return to CAL after the required warmup time. If the meter does not read on the CAL mark ± 2 divisions after warmup, refer to Paragraph 5-17 for Adjustment and Calibration procedure.

- d. When the 313A is terminated in a 75 ohm load and the meter is reading directly on the CAL mark, the output level can be read directly from the attenuator dials if the MAX OUTPUT switch is in the 0 DBM position. When the MAX OUTPUT switch is in the +10 DBM position, +10 DBM must be added algebraically to the attenuator dial reading for a correct indication of output level.
- e. Tune the 313A to the desired frequency using the continuously variable frequency control (MHz).

3-11. To operate the 313A in the TRACK 312A mode, proceed as follows:

- a. Connect the LOCAL OSCILLATOR OUTPUT and 30 MHz OUTPUT on the rear panel of the 312A to the LOCAL OSCILLATOR INPUT and 30 MHz INPUT on the rear panel of the 313A.
- b. Connect the output of the 313A through a 75 Ω cable and a 75 Ω feedthru termination (at the 312A end of the cable) to the 312A input.
- c. Place the 313A OSCILLATOR MODE switch to TRACK 312A and set the attenuator to 00.0 dB. Set the MAX OUTPUT switch to 0 dBm and the METER MODE switch to OUTPUT MONITOR.

- d. Set the 312A REFERENCE LEVEL to 0 dBm and the AMPLITUDE RANGE to 0 dB. Set the BAL/UNBAL switch to UNBAL and the INPUT MODE to BRIDGED, 75. Set the RECEIVER MODE switch to AM.
- e. The 312A meter should now indicate directly over the CAL mark and the 312A meter should indicate 0 dBm.
- f. To expand the 312A meter indication, connect the 312A RECORDER OUTPUT to the 313A RECORDER INPUT and change the 313A METER MODE switch to 312A EXPAND.

Adjust the SCALE OFFSET for a zero center scale reference. The 313A can expand any 312A meter indication between -7 dBm and +3 dBm.

3-12. NEGATIVE RECORDER INPUT.

3-13. If the 313A Meter Expand Amplifier is to be used with an instrument having a negative recorder output voltage, a minor modification must be made. To perform this modification, disconnect the wires connected to J10 pin 14 and J10 pin 9. Connect the wire removed from pin 14 to pin 9 and connect the wire removed from pin 9 to pin 14.

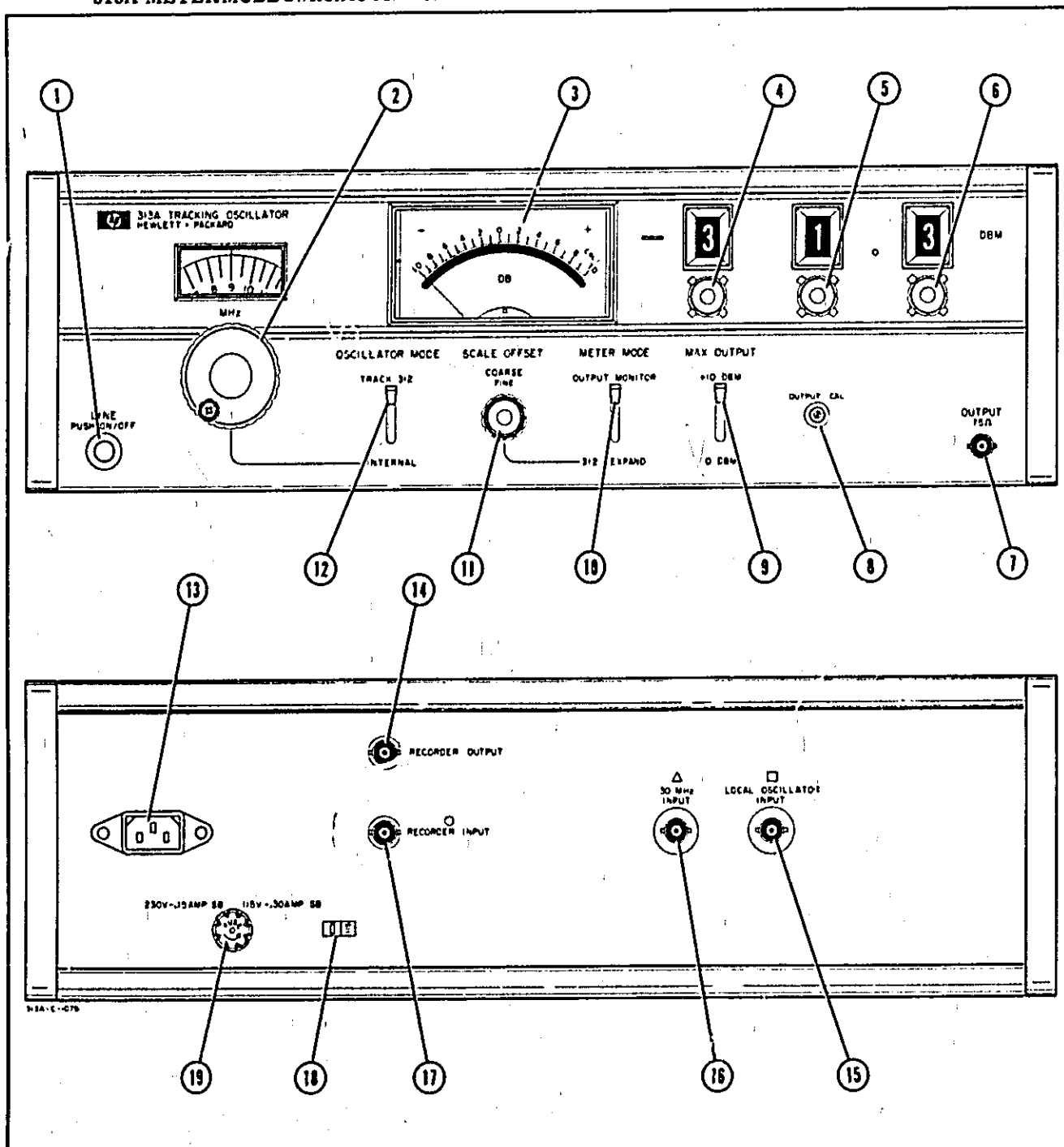


Figure 3-1. Location of Front and Rear Panel Controls, Indicators and Connectors

Table 3-1. Front and Rear Panel Controls, Indicators and Connectors

- ① **Line ON/OFF Switch:** When the instrument is connected to a power source and the switch is depressed, power is applied to the instrument and the lamp will illuminate indicating an ON condition.
- ② **Frequency Selector:** Selects output frequencies between 10 kHz and 22 MHz when operated in the INTERNAL mode.
- ③ **Meter:** Reads on the CAL mark in the OUTPUT MONITOR position of the METER MODE Switch, indicating that the 313A output level is calibrated or displays the 312A RECORDER OUTPUT on an expanded scale in the 312A EXPAND position of the METER MODE switch.
- ④ **10 DB Step Attenuator:** Selects output attenuation from 0 to 90 dB in 10 dB steps.
- ⑤ **1 DB Step Attenuator:** Selects output attenuation from 0 to 9 dB in 1 dB steps.
- ⑥ **.1 DB Step Attenuator:** Selects output attenuation from 0 to 0.9 dB in 0.1 dB steps.
- ⑦ **Output Connector:** Provides a 50 ohm unbalanced output (50 ohm unbalanced, Option 01).
- ⑧ **OUTPUT CAL:** Used to adjust the meter to indicate CAL.
- ⑨ **MAX OUTPUT Switch:** In the 0 DBM position, the output level can be read directly from the attenuator dials. In the +10 DBM position, the output level is increased by +10 DBM. This +10 DBM increase in output level must be algebraically added to the attenuator dial reading for a correct indication of output level.
- ⑩ **METER MODE Switch:** In the 312A EXPAND position, the RECORDER OUTPUT of the 312A is displayed on the 313A meter. In the OUTPUT MONITOR position, the 313A meter reads CAL indicating that the output of the 313A is calibrated. The output of the 313A can then be read directly in DBM from the attenuator dials provided the MAX OUTPUT switch is in the 0 DBM position.
- ⑪ **SCALE OFFSET:** Adjusts the meter for center scale reference when making an expanded meter reading. Both a Coarse and Fine adjustment are provided.
- ⑫ **OSCILLATOR MODE Switch:** In the TRACK 312A mode, the 313A Local Oscillator and Crystal Oscillator are disabled and the 312A outputs are selected to be used in the 313A. In the INTERNAL mode, the Model 313A Local Oscillator and Crystal Oscillator are activated.
- ⑬ **Input Power Receptacle:** Connects 115 or 230 volts to the instrument.
- ⑭ **RECORDER OUTPUT Connector:** Provides a dc output proportional to the ac output signal. This output is provided so that it can be monitored by external equipments. Source resistance of this output is 1000 ohms.
- ⑮ **LOCAL OSCILLATOR INPUT Connector:** Accepts the 312A LOCAL OSCILLATOR output when the 313A is operated in the TRACK 312A mode.
- ⑯ **30 MHz INPUT Connector:** Accepts the CRYSTAL OSCILLATOR output of the Model 312A when the Model 313A is operated in the TRACK 312A mode.
- ⑰ **RECORDER INPUT:** Accepts the RECORDER OUTPUT of the 312A for expansion on the 313A meter.
- ⑱ **115/230 Volt Switch:** Selects either 115V or 230V primary ac input power.
- ⑲ **Fuse (F1):** A 0.3 A slow-blow fuse F1 protects the instrument from overload when used on 115 volt primary power. When used on 230 volts ac, fuse F1 is a 0.15A slow-blow fuse.

THEORY

SECTION IV

THEORY OF OPERATION

4-1. GENERAL DESCRIPTION.

4-2. The Hewlett-Packard Model 313A TRACKING OSCILLATOR provides output levels from -99.9 dB to +10 dBm and an output frequency between 10 kHz and 22 MHz. Three front panel step attenuators provide 0 to 99.9 dB in 0.1 dB steps and a +10 dB increase in output level is available by means of the MAX OUTPUT switch. The 313A has an INTERNAL mode and a TRACK 312A mode of operation.

4-3. In the INTERNAL mode, the 313A Local Oscillator is activated and has a frequency range from 30 MHz to 52 MHz. The output of the Local Oscillator (A12) is mixed with a 30 MHz signal from the Crystal Oscillator A4. The output of Mixer A6 is the difference frequency, with a range between 0 and 22 MHz. This output is applied to the Low Pass Filter A7 where all frequencies above 22 MHz are attenuated. The Low Pass Filter output is coupled to Power Amplifier A8 where the signal is amplified and applied to the Output Attenuators and a Metering Circuit which monitors the output level. Additional attenuation is provided in 0.1 dB steps up to 0.9 dB by another step attenuator which controls the AGC voltage. The AGC voltage is applied to AGC Amplifier A5 which controls the 313A output level.

4-4. In the TRACK 312A mode of operation, the sequence is the same except that the 313A Local Oscillator and the 30 MHz Crystal Oscillator are disabled and external inputs from the 312A are substituted for these signals. The bandpass characteristics of the 312A are such that it is necessary to produce a frequency offset in the 313A output in order to keep the signal out of the 312A notch (See Figure 7-2). This 35 Hz offset is produced in the Single Sideband Generator A9 by mixing the 312A Crystal Oscillator output with a 35 Hz signal produced in the 313A.

4-5. The 313A has a Meter Expand Function which accepts an external input from the 312A RECORDER OUTPUT and expands the 312A meter reading for a 2 dB full scale (± 1 dB center scale) deflection for increased resolution.

4-6. CIRCUIT DESCRIPTION.

4-7. Refer to Figures 7-4 through 7-9 for the following discussions.

4-8. POWER SUPPLY (A1).

4-9. The power supply circuits in the 313A contain two regulated supplies which produce +20 volts and -20 volt outputs. Both supplies are identical except that the negative supply uses a reference diode and the positive supply utilizes the negative supply for its reference.

4-10. The +20 volt supply uses a conventional series type regulator. Transistor A1Q2 is the sensing element whose base is tied to a voltage divider between +20 volts and -20 volts. Any change in the +20 volt output is sensed by A1Q2, amplified and applied to the emitter of A1Q1. Since transistor A1Q1 controls the base current of Q1, this change will cause the conduction of Q1 to change in such a direction as to keep the +20 volt output constant. Feedback capacitor A1C1 further aids regulation by coupling any changes in the +20 volt output back to the junction of A1R2 and A1R3 to produce higher loop gain. Since the +20 volt supply is referenced to the -20 volt supply, any change in the -20 volt supply will also change the +20 volt output. If for example, the -20 volt output should change to -21 volts, the positive supply would change to +21 volts. Adjusting A1R15 varies both supplies.

4-11. The -20 volt supply is identical in operation to the +20 volt supply except that A1CR6 is used to hold the emitter of A1Q4 at a constant voltage.

4-12. LOCAL OSCILLATOR (A12).

4-13. The Local Oscillator function is to produce stable frequencies between 30 MHz and 52 MHz. The oscillator frequency is controlled by a front panel knob which varies tuning capacitor C5.

4-14. The Oscillator is a field effect transistor (FET) A12Q1 whose drain load is a tuned circuit consisting of L1, C5, A12C1 and A12C2. The signal is taken from the drain of A12Q1 and coupled to the gate of A12Q2 which serves as a buffer amplifier and to match the oscillator output to the input of the Broadband Amplifier A11. Feedback is provided through A12C6, A12R4, and A12C5. Diodes A12CR1 and A12CR2 serve to limit the amplitude of the feedback signal to 0.6 V p-p.

4-15. In the TRACK 312A mode, the oscillator is disabled by removing the B-voltage.

4-16. CRYSTAL OSCILLATOR (A4).

4-17. Crystal Oscillator A4 provides a 30 MHz signal through the AGC amplifier to the Mixer A6. The frequency of oscillations is controlled by A4Y1 which is a third overtone quartz crystal. Feedback is provided from the collector of A4Q1 through the crystal to the base of A4Q1. Collector circuit A4L2 and A4C4 form a 30 MHz tuned circuit. The output signal is coupled through A4R4 to the AGC Amplifier A5.

4-18. When the 313A is operated in the TRACK 312A mode, Crystal Oscillator A4 is disabled by removing B-voltage.

4-19. BROADBAND AMPLIFIER (A11).

4-20. Broadband Amplifier A11 consists of three stages of amplification and receives its input from one of two sources depending upon the position of the front panel OSCILLATOR MODE switch.

4-21. When the OSCILLATOR MODE switch is in the INTERNAL position, A11K1 is deenergized and the Model 313A Local Oscillator is coupled to the base of A11Q1. During the time that A11K1 is deenergized, A11K2 is energized and the External Oscillator Input is grounded.

4-22. When the 313A is operated in the TRACK 312A mode, A11K2 is deenergized and A11K1 is energized. During this time the ground is removed from the external LOCAL OSCILLATOR INPUT and the external signal is fed through A11K1 to the base of A11Q1. The 313A Local Oscillator is disabled during this time.

4-23. Amplifier A11Q1 has a 50Ω input impedance. Here the signal is amplified and coupled by A11C6 to the base of A11Q2 which has as its load, inductor A11L1 which helps shape the overall frequency response to the Broadband Amplifier. The signal is then coupled by A11C8 to emitter follower A11Q3 which has a low output impedance to match the input of Mixer A6.

4-24. DELTA OSCILLATOR (A2).

4-25. Delta Oscillator A2 is a phase shift oscillator which produces a 35 Hz signal to be used by the Single Sideband Generator. The frequency of oscillation is determined by A2C1 - A2R3 and A2C3 - A2R8. The reactances of A2C1 and A2C3 will be equal to the resistance of A2R3 and A2R8 respectively at the frequency of oscillation. Feedback is provided between the output of A2Q5 and the input of A2Q1.

4-26. Lamp A2DS1 is included to provide amplitude stability. If the amplitude of the signal across A2R12 should increase, the resistance of A2DS1 increases and reduces the gain of A2Q5 to keep the output amplitude constant. Two outputs are provided to the Single Sideband Generator, one at 0° and one at 90°.

4-27. BUFFER AMPLIFIER (A10).

4-28. Buffer Amplifier A10 provides isolation between the external 30 MHz INPUT and the Single Sideband Generator A9. When the 313A is operated in the TRACK 312A mode, the Buffer Amplifier is energized by applying B-voltage through the OSCILLATOR MODE switch located on the front panel.

4-29. Amplifier A10Q1 has a 50Ω input impedance and receives its input from a BNC connector J3 located on the rear panel of the 313A. The collector circuit of A10Q1 is tuned to 30 MHz and couples the signal to A10Q2 which is also tuned to 30 MHz. The output of A10Q2 goes to the Single Sideband Generator to be used as a switching signal.

4-30. SINGLE SIDEBAND GENERATOR (A9).

4-31. The function of the Single Sideband Generator is to mix the 30 MHz Crystal Oscillator frequency output of the Model 312A with a 35 Hz signal in the 313A. This mixing in the Single Sideband Generator produces a resultant frequency at 29.999965 MHz which is mixed with the Local Oscillator output of the Model 312A in Mixer A6. This 35 Hz offset is necessary because of the bandpass characteristics of the Model 312A. When making a closed loop test of an instrument, the output of the 313A is coupled to the device under test. The output of the device under test is then fed to the input of the 312A where it is mixed with a Local Oscillator frequency 30 MHz above the input signal frequency. This 30 MHz difference frequency falls into a notch in the 312A bandpass. Therefore, it is necessary to produce a slight offset in the 313A output so that this signal can be passed by the 312A.

4-32. Operation of the Single Sideband Generator can be best understood by referring to Figure 4-1. The 30 MHz Crystal Oscillator Input signal current from Buffer Amplifier A10 is phase advanced 45 degrees by capacitor A9C1 and is retarded 45 degrees by inductor A9L1. The signals at the primaries of A9T1 and A9T2 are thus phase shifted 90 degrees with respect to each other. The two inputs from the 35 Hz Delta Oscillator are also 90 degrees apart in order to satisfy the trigonometric identities shown in Figure 4-1. Assume that the top of A9T1 secondary is in its positive half cycle and the bottom of A9T1 is in its negative half cycle. Diodes A9CR1 and A9CR2 are reverse biased and no signal current flows. Terminal 2 of A9T3 is therefore an open circuit. When the 30 MHz switching signal reverses in phase, diodes A9CR1 and A9CR2 are now forward biased and signal current flows through transformer A9T1, A9CR2, A9R7 and A9CR1. Terminal 2 of A9T3 is now effectively grounded and the signal is induced into the secondary of A9T3. The operation of the remaining half of the Single Sideband Generator is identical to the first except that the switching signal at A9T2 is 90 degrees phase shifted with respect to the signal at A9T1.

4-33. The Single Sideband Generator A9 accomplishes multiplication of the 35 Hz Delta Oscillator frequency (f_{Δ}) by the 30 MHz switching signal (f_{SW}) as defined by the trigonometric functions.

$$\text{Mixer \#1: } (\sin f_{SW} t) \times (\sin f_{\Delta} t) = 1/2 [\cos (f_{SW} + f_{\Delta}) t - \cos (f_{SW} - f_{\Delta}) t]$$

$$\text{Mixer \#2: } (\cos f_{SW} t) \times (\cos f_{\Delta} t) = 1/2 [\cos (f_{SW} + f_{\Delta}) t + \cos (f_{SW} - f_{\Delta}) t]$$

4-34. The outputs of Mixer #1 and Mixer #2 are added algebraically in A9R10 for an output of $\cos (f_{SW} + f_{\Delta}) t$. The mixers are balanced so that the switching frequency (f_{SW}) does not appear in the output. Resistors A9R1 and A9R2 keep any reflections back into the primaries of A9T1 and A9T2 constant and make them appear purely resistive. Capacitors A9C2 and A9C3 are used to trim out any reactances that might be reflected back into the primaries of A9T1 and A9T2 respectively.

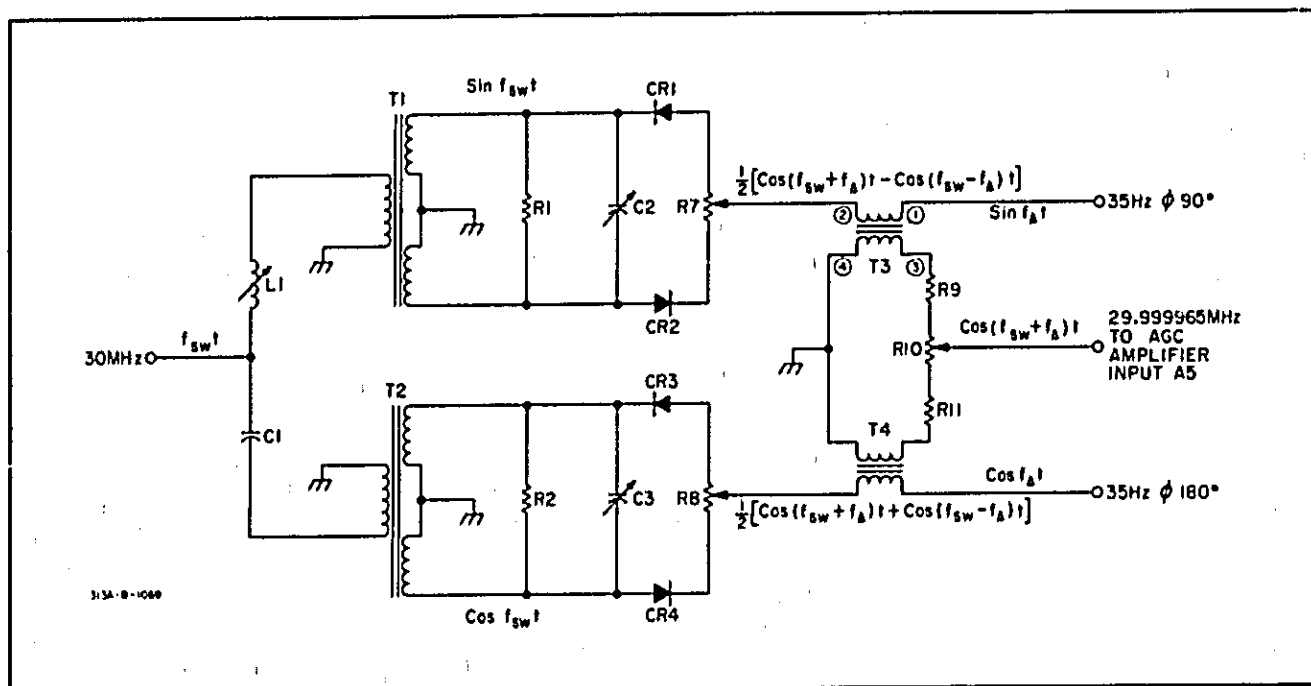


Figure 4-1. Single Sideband Generator A9 Simplified Schematic

4-35. AGC AMPLIFIER. (A5)

4-36. The AGC Amplifier receives its input from either the Crystal Oscillator A4 in the INTERNAL mode or from the Single Sideband Generator A9 in the TRACK 312A mode.

4-37. In the INTERNAL mode, the 30 MHz crystal controlled signal from A4 is coupled to the base of A5Q1 where it is amplified. The output of A5Q1 is then coupled to the AGC control circuit consisting of A5T1, A5C6, A5CR1, A5CR2 and A5T2. The AGC control circuit sets the signal amplitude depending upon the magnitude of the AGC control voltage. This control voltage is a bias for A5CR1 and A5CR2 which determines their conduction and thus the amount of attenuation of the signal through the diodes. Since the AGC circuit is a closed loop, any change in the 313A output amplitude will cause a corresponding change in the AGC control voltage by the AGC Control Amplifier A3. Thus the gain of AGC Amplifier A5 can be controlled by a dc voltage. This change in AGC voltage acts to keep the output level of the 313A constant.

4-38. In the TRACK 312A mode the input to the AGC Amplifier comes from the Single Sideband Generator A9 and the 30 MHz Crystal Oscillator A4 is disabled. This sideband signal is 29.999965 MHz which is the difference between the 35 Hz signal from the Delta Oscillator A2 and the 30 MHz Crystal Oscillator signal from the 312A.

4-39. MIXER (A6).

4-40. The Mixer A6 is a balanced modulator that receives one input from the Broadband Amplifier A11 and the other from the AGC Amplifier A5. The input from the Broadband Amplifier can vary from 30 MHz to 52 MHz depending upon the setting of the 313A front

panel frequency control. The input from the AGC Amplifier is 30 MHz which comes from Crystal Oscillator A4 when operated in the INTERNAL mode or from an external source when operated in the TRACK 312A mode.

4-41. The Mixer output contains both the sum and difference frequencies and since it is desirable to use the difference frequency, the output is coupled to Low Pass Filter A7 where all frequencies above 22 MHz are greatly attenuated.

4-42. LOW PASS FILTER (A7).

4-43. Low Pass Filter A7 is 13 pole Tchebycheff filter whose function is to pass all frequencies between dc and 22 MHz uniformly while attenuating all undesirable frequency components above 22 MHz. Sharp cutoff occurs at approximately 24 MHz in order to eliminate any unwanted harmonics and noise components. The output is coupled to Power Amplifier A8 for further amplification.

4-44. POWER AMPLIFIER (P/O A8).

4-45. The Power Amplifier is located on the A8 Assembly along with the 10 dB Attenuator pad and the Average Detector. The Power Amplifier consists of seven stages of amplification, A8Q1 through A8Q7 along with associated biasing transistors, A8Q8 through A8Q12. Emitter follower A8Q1 provides isolation between the Low Pass Filter output and the amplifier. Emitter follower A8Q7 provides isolation and impedance matching with the 10 dB pad and the input to the average detector.

4-46. Since it is desirable that the amplifier gain be as flat as possible over the 0-22 MHz range, negative feedback is provided in two different ways. The first

method provides negative feedback through resistors tied between the collectors of A8Q2 through A8Q6. Coils A8L1 and A8L2 are provided for high frequency shaping. The second method of feedback maintains constant amplifier gain by controlling the conduction level of transistors A8Q2 through A8Q6. Biasing transistors A8Q8 through A8Q12 will sense any change in the conduction level of A8Q2 through A8Q6 respectively and changes the dc bias on these transistors, thus restoring the collector voltage. The bases of all biasing transistors are tied together to a fixed voltage so that only changes in the signal amplifier collector voltage will determine conduction.

4-47. Emitter follower A8Q7 has two outputs, one goes to the Average Detector and the second output goes to a 10 dB attenuator pad which is controlled by a front panel switch marked MAX OUTPUT. When the switch is in the +10 DBM position, A8K1 is energized, shorting A8R45 and A8K2 is deenergized which removes ground from A8R46, thus providing a + 10 DBM increase in the Model 313A output. This +10 DBM increase in output level must be algebraically added to the attenuator dial reading for a correct indication of output level. In the 0 DBM position of the switch, 10 dB of attenuation is inserted by energizing A8K2 and deenergizing A8K1.

4-48. AVERAGE DETECTOR (P/O A8).

4-49. The Average Detector receives its input from the Power Amplifier through A8R49 which is selected for an optimum loop gain. The output of emitter follower A8Q13 is then fed to A8Q14 which has a high output impedance so that maximum signal current will flow in diodes A8CR1 and A8CR2. Both capacitors A8C35 and A8C36 establish a positive potential at the diode junctions. An increase in signal amplitude to the detector will cause the charge on A8C36 to increase and the charge on A8C35 to decrease. This change is then coupled to the AGC loop which cancels any variations that might occur. Resistor A3R31 is used to adjust the output level. The output of the Average Detector goes to the AGC Differential Amplifier and to the Metering Circuit.

4-50. ATTENUATORS (A13, A14 and A15).

4-51. Attenuator A13 provides 0 to 90 dB attenuation by switching different combinations of the 60 dB, 30 dB, 20 dB and 10 dB attenuator pads. Attenuator A14 provides 0 to 9 dB attenuation by switching combinations of the 6 dB, 3 dB, 2 dB and 1 dB attenuator pads. These two attenuators are connected in series for a total range of 0 to 99 dB. A 25 Ω resistor is connected in series with the output of A14 to form a 75 Ω output.

4-52. Attenuator A15 works in conjunction with the AGC circuit to control the output of the 313A. This attenuator provides a shunt current path around A3Q1. This change in current through A3Q1 changes its collector voltage and thus the AGC voltage. The change in AGC voltage is coupled to AGC Amplifier A5 where its gain is controlled in accordance with the resistance values selected in the 0.1 dB Step Attenuator. The output of the 313A can be changed in 0.1 dB steps up to 0.9 dB by Attenuator A15.

4-53. METER EXPAND AMPLIFIER (P/O A3).

4-54. The purpose of the Meter Expand Amplifier is to use the RECORDER OUTPUT of the Model 312A and expand the reading on a 2 dB full scale meter movement so that better resolution can be obtained. The input to the Meter Expand Amplifier comes from a BNC type connector J5 on the rear panel and is coupled directly to A3Q9. Transistors A3Q9 and A3Q10 form a differential amplifier with high impedance A3Q11 acting as their constant current source. Transistors A3Q7 and A3Q8 amplify the signal and reference it to ground before being applied to the meter. Transistor A3Q12 is in parallel with meter M1 and is used for calibration. Conduction of A3Q12 is controlled by A3R31. Transistor A3Q13 is a temperature compensating device for A3Q11 and A3Q12. If the Vbe of A3Q11 should change because of temperature variations, this change will be exactly compensated for by the change in A3Q13 due to this temperature change. The emitter of A3Q13 is held at a constant potential by zener diode A3CR1.

4-55. When the 313A is used in the Meter Expand function with a given input to transistor A3Q9, the Model 313A meter is adjusted by the SCALE OFFSET for a zero center scale reference reading. Since the Meter Expand Amplifier has a constant gain with a given setting of the SCALE OFFSET, any variations in the input will cause deflection of meter M1. A 1 dB change in the input will cause a full scale deflection of M1. When operated in the Meter Expand function, the output that normally drives M1 is routed through the Meter Expand switch to a dummy load consisting of R4 and R5.

4-56. Meter M1 is a 300 μ A taut band zero left movement which is calibrated for a 2 dB full scale deflection. When the 313A is operated in the OUTPUT MONITOR mode, the meter deflects to the CAL mark. The output is then calibrated and can be read directly from the attenuator dials provided the MAX OUTPUT switch is in the 0 DBM position.

4-57. AGC CONTROL AMPLIFIER (P/O A3).

4-58. The AGC Control Amplifier is part of module A3 and its function is to use the output of the Average Detector to establish an AGC voltage. This AGC voltage is used by the AGC Amplifier A5 in maintaining a uniform output level in the 313A.

4-59. The input to the AGC Control Amplifier is applied to the emitter of A3Q1 and A3Q2 with A3Q2 acting as a temperature compensating device for A3Q1. The AGC voltage developed in the AGC Amplifier is determined by the amount of current flowing through transistor A3Q1. The 0.1 dB Step Attenuator is connected across transistor A3Q1 and is used to shunt current around A3Q1. By shunting current around A3Q1, the AGC voltage changes and thus the output level of the 313A. The output of A3Q1 is coupled to a feedback amplifier consisting of transistor A3Q3 through A3Q6. Feedback path is from the junction of A3R10 and A3R12 to the base of differential amplifier transistor A3Q4. The AGC level can be set by adjusting A3R14.

MAINTENANCE

WARNING

THESE SERVICING INSTRUCTIONS
ARE FOR USE BY QUALIFIED PER-
SONNEL ONLY. TO AVOID ELEC-
TRICAL SHOCK, DO NOT PERFORM
ANY SERVICING OTHER THAN THAT
CONTAINED IN THE OPERATING
INSTRUCTIONS UNLESS YOU ARE
QUALIFIED TO DO SO.

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary in the service and maintenance of the -hp- Model 313A. Included are performance checks, adjustment and calibration procedures and troubleshooting procedures.

5-3. The test equipment needed to properly maintain and service the 313A is listed in Table 5-1. Included in Table 5-1 is the equipment to be used, required specifications and recommended type. If the recommended model is not available, other equipments may be substituted provided they meet the required specifications.

5-4. METER MECHANICAL ZERO.

5-5. Mechanical zeroing of the front panel meter should be performed before any performance checks or adjustments are performed. To do this, turn the equipment off for 30 seconds to allow time for all capacitors to discharge and proceed with the procedure described in Paragraph 3-6.

5-6. FACTORY SELECTED VALUES.

5-7. Factory selected values are denoted on the schematic diagrams by an asterisk. Reference is also made to the paragraph number in the manual where the method of selection can be found.

5-8. PERFORMANCE CHECKS.

5-9. The performance checks presented in this section are in-cabinet checks designed to compare the 313A with its published specifications. These checks can be used for incoming inspection, periodic maintenance checks and to verify performance after adjustment or repair.

5-10. DIAL ACCURACY CHECK.

- a. Connect the 313A output to the electronic counter using an RG-59B/U (75 Ω) cable and a 75 Ω feedthru termination and set the 313A controls as follows:

OSCILLATOR MODE INTERNAL
METER MODE OUTPUT MONITOR
ATTENUATORS 00.0
MAX OUTPUT +10 DBM

- b. Adjust the electronic counter control to read frequency.
- c. Check the frequency dial accuracy at 1 MHz and at 2 MHz. The electronic counter reading should match the dial setting ± 220 kHz.

- d. Check the frequency dial accuracy at all integral MHz markers from 2 MHz to 8 MHz. The electronic counter reading should match the dial setting ± 660 kHz.
- e. Check the frequency dial accuracy at all integral MHz markers from 8 MHz to 22 MHz. The electronic counter reading should match the dial setting ± 1.1 MHz.
- f. If steps a through e do not meet specifications, refer to Paragraph 5-17 for adjustment and calibration procedures.

5-11. OUTPUT MONITOR CHECK.

- a. Set the Model 313A controls as follows:

OSCILLATOR MODE INTERNAL
METER MODE OUTPUT MONITOR
MAX OUTPUT +10 DBM
FREQUENCY DIAL 1 MHz
ATTENUATORS 00.0 DB

- b. Set the 400AC Voltmeter to the 1 V range and connect it to the output of the 313A using a 75 ohm cable and a 75 ohm feedthrough termination at the voltmeter end of the cable.
- c. The 313A meter should read directly over the CAL mark on the meter face and the 400F should indicate $0.866 \text{ V} \pm 0.008 \text{ V}$ (0.707 ± 0.007 Option 01).
- d. If the Output Monitor Check does not meet the specifications of step c, refer to Paragraph 5-17 for Adjustment and Calibration Procedure.

5-12. METER EXPAND AND TRACKING CHECK.

- a. Connect the 313A, Meter Expand Test Set and the 1 dB/step substitution attenuator as shown in Figure 5-1.
- b. Change the 313A METER MODE switch to 312 EXPAND.
- c. Connect the 3440A dc Digital Voltmeter to the test point on the Meter Expand Test Set and adjust the output of the test set to precisely 1.000 V.
- d. Turn the substitution attenuator full clockwise (0dB). Adjust the 313A SCALE OFFSET Coarse control full counterclockwise with the Fine Control centered. The 313A meter should read 0.0 or less.

Table 5-1. Required Test Equipment and Accessories

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
Oscilloscope	Passband: DC to 30 MHz Sensitivity: 50 mV/cm Input Impedance: 1 M Ω	-hp- Model 1700B
Wave Analyzer	Local Oscillator Output: 50 mV into 50 ohms 30 MHz Output: 30 mV into 50 ohms Recorder Output: 1 V maximum into 1000 ohms	-hp- Model 312 B
Wave Analyzer	Selectivity: ± 30 Hz at least 60 dB down Dynamic Range: 70 dB Input Reference Level: 1 volt	-hp- Model 3581A
Electronic Counter	Frequency Range: 0 to 22 MHz Accuracy: ± 10 Hz	-hp- Model 5245L
Digital Multimeter	Range: 1 V, 10 V and 100 V Accuracy: 0.1% Resolution: 4 digits Sensitivity: 1 mV full scale	-hp- 34702A with 34740A Display
DC Null Voltmeter	Range: 10 mV Full Scale 30 μ V Center Scale Accuracy: $\pm 2\%$ Input Impedance: 100 k Ω	-hp- Model 419A
Bucking Supply 0-10 mV	See Figure 5-2 for schematic a. Resistor: fxd 6500 $\Omega \pm 1\%$ R1 b. Resistor: var 500 $\Omega \pm 10\%$ R2 c. Resistor: var 50 $\Omega \pm 5\%$ R3 d. Battery: 1.34 V	-hp- Part No. 0811-0392 -hp- Part No. 2100-0324 -hp- Part No. 2100-1481 Mallory RM-42R
Thermal Converter	Output: 3.5 mV dc output for 700 mV ac input Impedance: 75 Ω Accuracy: 0.25% 10 kHz to 22 MHz	-hp- Model H01-11050A
Thermal Converter	Output: 5 mV dc output for 700 mV ac input (Option 01 only) Impedance: 50 Ω Accuracy: 0.25% from 10 kHz to 22 MHz	-hp- Model 11050A
AC Voltmeter	Sensitivity: 100 μ V Full Scale Accuracy: 0.5% at 866 mV at 1 MHz	-hp- Model 400F with known accuracy
AC Voltmeter	Sensitivity: 10 mV Full Scale Accuracy: 1% Passband: 500 kHz to 70 MHz	-hp- Model 3406A
Amplifier	Passband: 10 kHz to 22 MHz Gain: 40 dB	-hp- Model 461A
Distortion Filter	Notch Frequency: 1 MHz	See Figure 5-5
Distortion Filter	Notch Frequency: 9.5 MHz	See Figure 5-5
Distortion Filter	Notch Frequency: 20.5 MHz	See Figure 5-5
Meter Expand Test Set	See Figure 5-1 for schematic a. Resistor: fxd 464 $\Omega \pm 1\%$ R1 b. Resistor: var 75 $\Omega \pm 10\%$ R2 c. Resistor: fxd 56.2 $\Omega \pm 1\%$ R3 d. Resistor: fxd 49.9 $\Omega \pm 1\%$ R4 e. Resistor: fxd 1 k $\Omega \pm 1\%$ R5	-hp- Part No. 0698-0090 -hp- Part No. 2100-0076 -hp- Part No. 0757-1001 -hp- Part No. 0757-0072 -hp- Part No. 0757-0021

Table 5-1. Required Test Equipment and Accessories (Cont'd)

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
10 dB/Step Substitution Attenuator	Range: 0 to 120 dB in 10 dB steps	-hp- Model 355D with known accuracy
1 dB/Step Substitution Attenuator	Range: 0 to 12 dB in 1 dB steps	-hp- Model 355C with known accuracy
50 Ω Feedthru	Accuracy: 1% (Option 01 only)	-hp- Model 11048B
75 Ω Feedthru Termination	Accuracy: 1%	-hp- Model 11094A
75 Ω to 50 Ω Impedance Converter	Accuracy: 0.25% Input Impedance: 75 Ω Output Impedance: 50 Ω	See Figure 5-3
Probe	Attenuation: 10:1 Passband: DC to 30 MHz Accuracy: 2%	-hp- Model 10001A
Cable	Impedance: 50 Ω Length: 24" (3 supplied with 313A)	-hp- Model 11086A
Cable, BNC to Alligator Clip	Length: 44"	-hp- Model 11037A
Cable, BNC to BNC	Impedance: 50 Ω Length: 48" (Option 01 only)	10503A

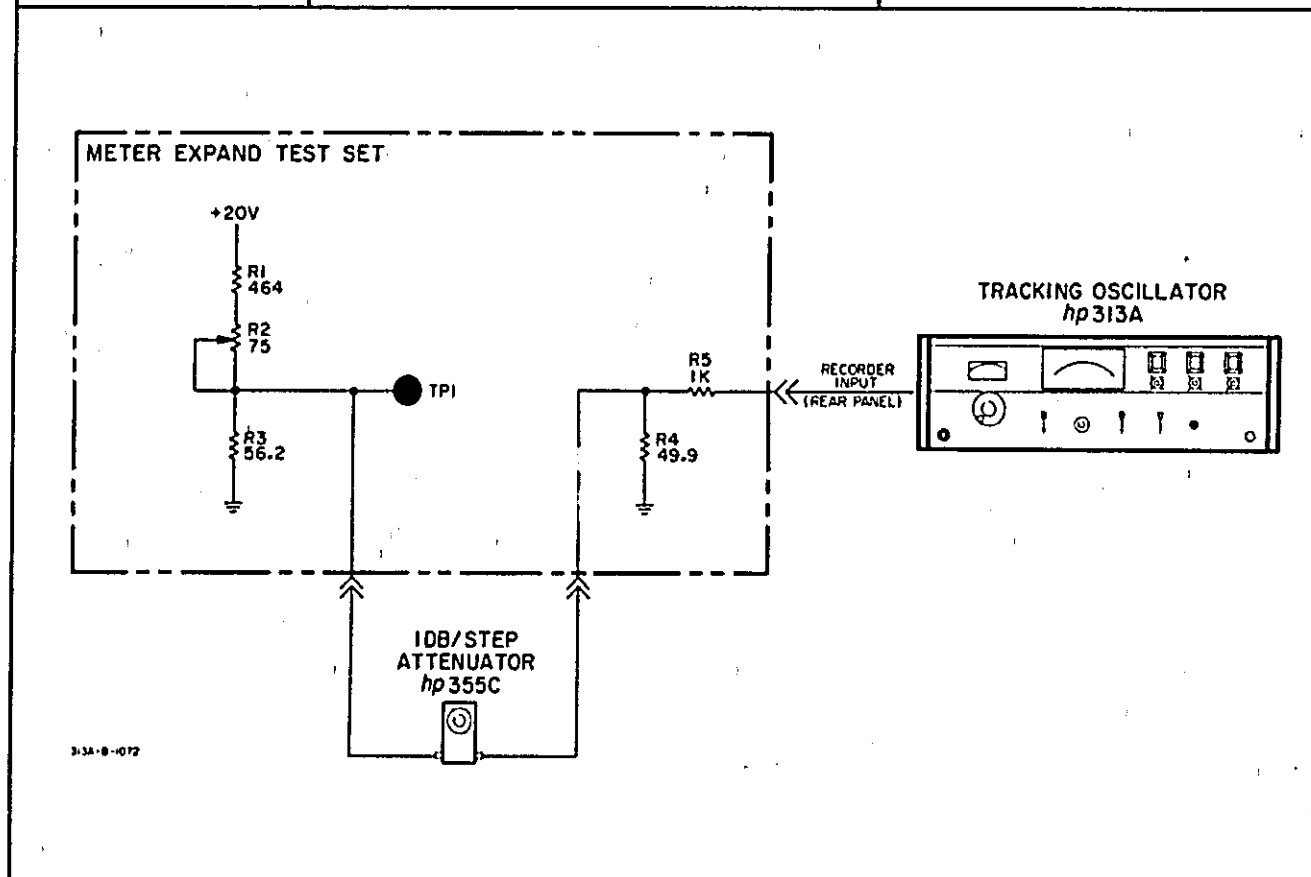


Figure 5-1. Meter Expand and Tracking Test Setup

- c. Adjust the 313A SCALE OFFSET control so that the 313A meter reads +1.0. Turn the substitution attenuator 2 steps counterclockwise (2 dB). The 313A meter should read -1.0 ± 0.05 dB.
- f. Using the procedure outlined in step e, continue checking the 313A meter tracking through the entire range of the SCALE OFFSET control. In each step, the 313A meter should read -1.0 ± 0.05 dB.
- g. With the substitution attenuator set to 10 dB, turn the 313A SCALE OFFSET Coarse control full clockwise with the Fine control centered. The 313A meter should read 0.0 or greater.
- h. If the Meter Expand and Tracking performance checks do not meet published specifications, refer to Paragraph 5-17 for Adjustment and Calibration procedures.

5-13. OUTPUT FREQUENCY RESPONSE CHECK.

NOTE

If a 312B Wave Analyzer is available, perform steps a through l.
If a 312B is not available, perform steps i through l.

- a. Connect the 313A, 312B, Thermal Converter, Bucking Supply and 419A DC Null Voltmeter as shown in Figure 5-2.
- b. Set the 313A controls as follows:
 OSCILLATOR MODE . . . TRACK 312B
 METER MODE OUTPUT MONITOR
 MAX OUTPUT +10 DBM
 ATTENUATORS 00, 0

- c. Set the 312B FREQUENCY RANGE to 0 and adjust the variable frequency control for 1000.00 kHz.
- d. With the Bucking Supply OFF, set the 419A to the 10 mV range and zero the meter. Push the VM button on the 419A.
- e. Turn ON the Bucking Supply and adjust the controls for a null on the 419A meter.
- f. Turn the 419A to the 300 μ V range and if necessary readjust the controls on the Bucking Supply for a null on the 419A meter.
- g. Turn the 313A 0.1 dB attenuator one step counterclockwise and note the reading on the 419A meter. This represents 0.1 dB deviation for the following checks. Return the 313A 0.1 dB attenuator to 0.
- h. Using the FREQUENCY RANGE and variable frequency control, slowly tune the 312B through the frequency range between 10 kHz and 18 MHz observing any deviations on the 419A meter. The 419A meter should not deviate more than the value noted in step g.
- i. Change the 313A OSCILLATOR MODE switch to INTERNAL and set the 313A frequency dial to 1 MHz. If necessary readjust the Bucking Supply for a null on the 419A meter.
- j. Turn the 313A 0.1 dB attenuator one step counterclockwise and note the reading on the 419A meter. This reading represents 0.1 dB deviation. Return the attenuator to 0.

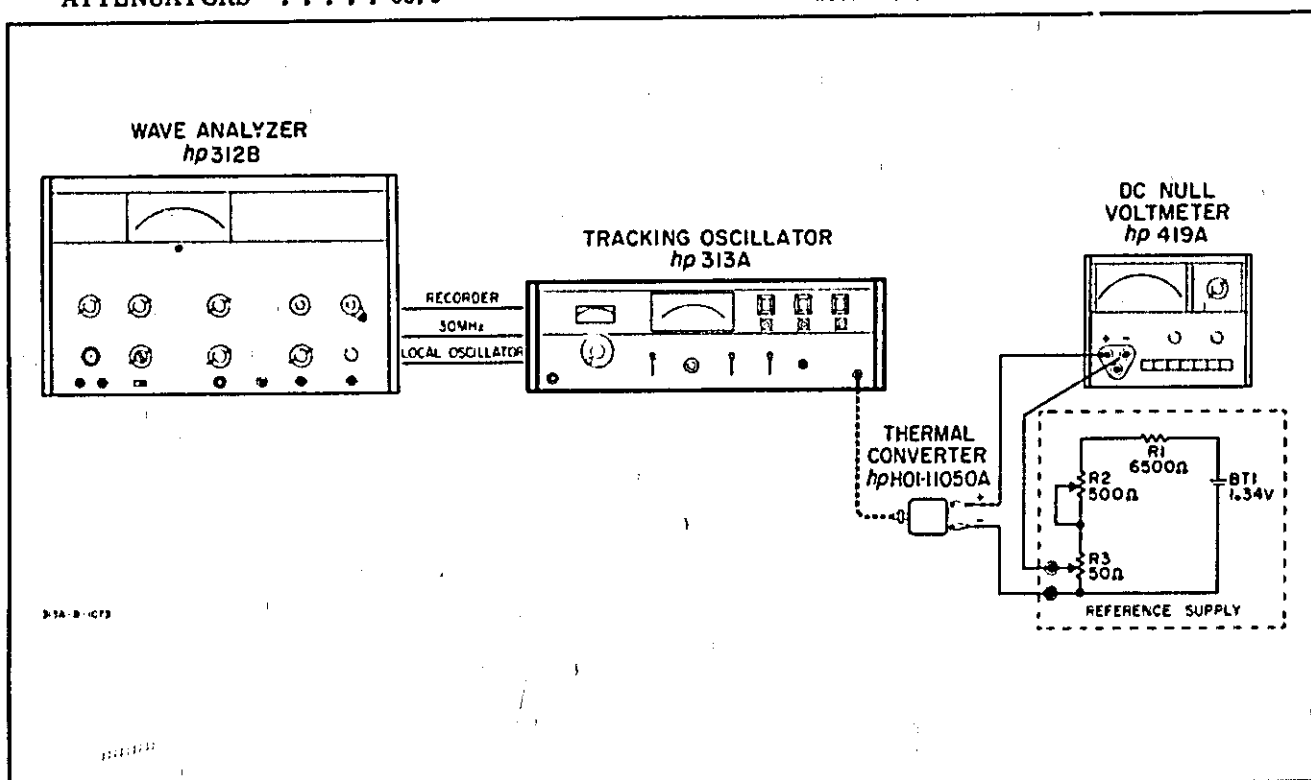


Figure 5-2. Output Frequency Response Test Setup

- k. Slowly tune the 313A through the frequency range of 10 kHz to 22 MHz noting any deviations on the 419A meter. Any deviations noted should not exceed the value recorded in step j.
- l. Change the 313A MAX OUTPUT switch to 0 DBM and the 419A RANGE switch to 30 μ V. Repeat steps i through k.
- m. If the Output Frequency Response check does not meet the specifications of steps h and k, refer to Paragraph 5-17 for Adjustment and Calibration procedures.

NOTE

The above procedure assumes that the Thermal Converter is perfectly flat over the frequency range used. Any deviations in the Thermal Converter calibration chart should be subtracted from the reading obtained in the 313A frequency response curve.

5-14. ATTENUATOR ACCURACY CHECK.

- a. Connect the 313A, 312B, 461A and 34702A and the substitution attenuator as shown in Figure 5-3(a).

NOTE

Float the 313A Tracking Oscillator by using an adequate isolation transformer to isolate chassis ground from power line ground.

- b. Set the 313A controls as follows:

OSCILLATOR MODE INTERNAL
METER MODE 312 EXPAND
FREQUENCY 1 MHz
ATTENUATORS 00.0
MAX OUTPUT + 10 dBm

- c. Set the 10 dB/step substitution attenuator to 90 dB.

- d. Set the 34702A to 1 V dc Range.

- e. Set the 312B controls as follows:

FREQUENCY 1000.00 kHz
REFERENCE LEVEL 40 dBm
AMPLITUDE RANGE -10 dB
RECEIVER MODE AM
BANDWIDTH 3000 Hz

- f. Set the 461A to 40 dB.
- g. Adjust the 313A Frequency for a maximum on scale meter indication on the 312B.
- h. Set the 312B Receiver Mode to AM/AFC and adjust the 312B Cal. Adj. for a 1.000 V dc reading on the 3470A Display.
- i. Perform the attenuator checks listed in Table 5-2 with the 313A Attenuators and the 10 dB step substitution attenuator set as indicated.

NOTE

In the following attenuator checks, it is assumed that the substitution attenuators have a perfectly flat frequency response over the frequency range used. If there are any variations in the response of the substitution attenuators in the frequency range of 10 kHz to 22 MHz, these deviations must be considered when checking the 313A attenuators.

- j. Repeat Steps a through i with the 313A and 312B frequencies set to 10 kHz and again with the frequencies set to 18 MHz. (If 312B-H01 is available, check at 22 MHz).
- k. Connect the 313A and 312B and 1 dB step substitution attenuator as in Figure 5-3(b).

- l. Set 313A controls as follows:

OSCILLATOR MODE TRACK 312B
METER MODE 312 EXPAND
ATTENUATORS 00.0

Table 5-2. 10 dB Step Attenuator Check.

313A ATTENUATORS	10 dB/STEP SUBSTITUTION ATTENUATOR	34740A DISPLAY INDICATION
00.0	90	1.000 Ref.
10.0	80	.989 to 1.011 (\pm .1 dB)
20.0	70	.989 to 1.011 (\pm .1 dB)
30.0	60	.989 to 1.011 (\pm .1 dB)
40.0	50	.989 to 1.011 (\pm .1 dB)
50.0	40	.989 to 1.011 (\pm .1 dB)
60.0	30	.977 to 1.023 (\pm .2 dB)
70.0	20	.977 to 1.023 (\pm .2 dB)
80.0	10	.977 to 1.023 (\pm .2 dB)
90.0	0	.977 to 1.023 (\pm .2 dB)

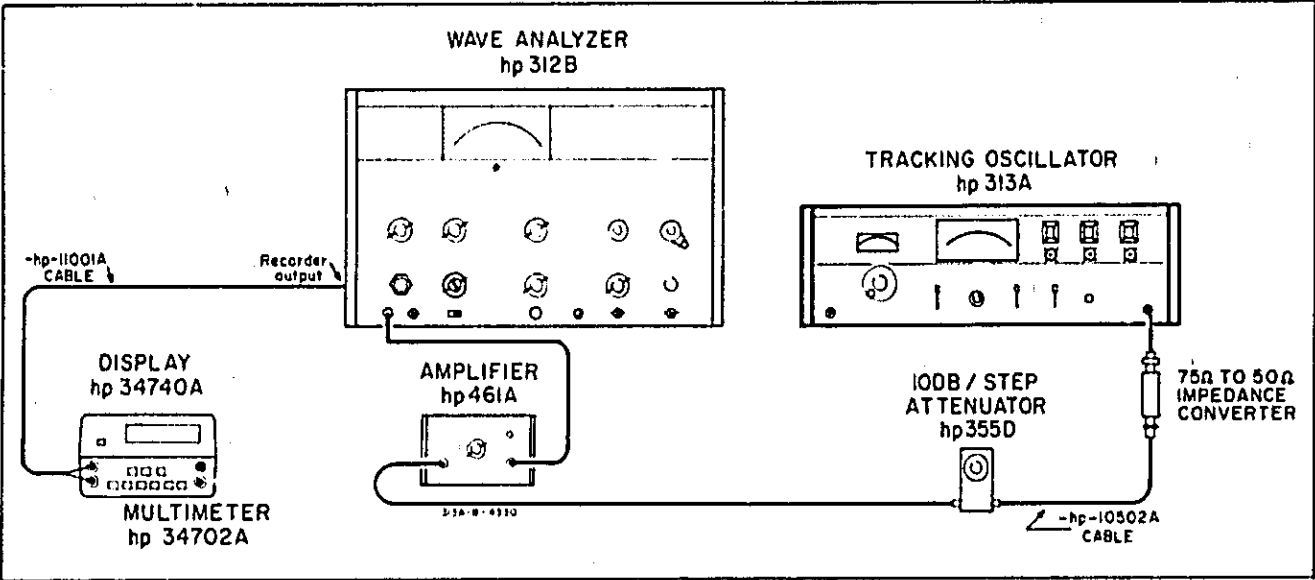


Figure 5-3(a). Attenuator Accuracy Test Setup.

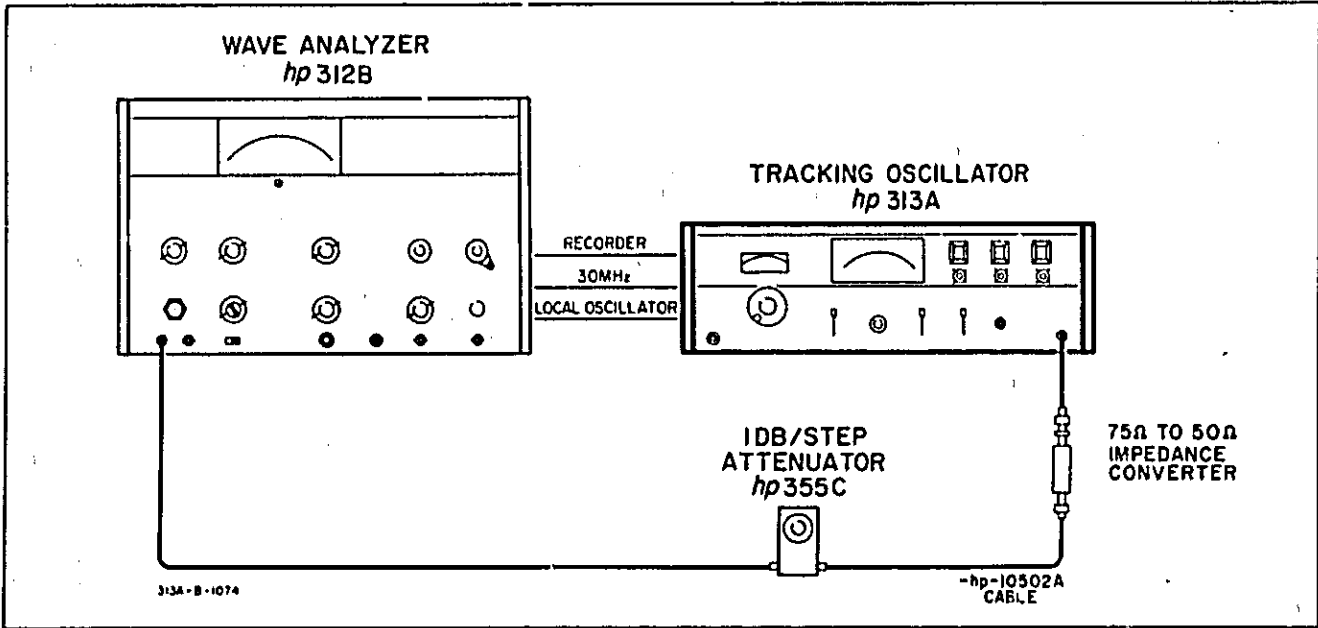


Figure 5-3(b). Attenuator Accuracy Test Setup.

MAX OUTPUT +10 DBM
RECEIVER MODE AM

to 0.0 and perform the checks listed in Table 5-4.

m. Set the 312B controls as follows:

FREQUENCY 1000.00 kHz
REFERENCE LEVEL 0 DBM
AMPLITUDE RANGE 0
RECEIVER MODE AM
BANDWIDTH 3000 Hz

p. Repeat Steps k through o with the 312B frequency set to 10 kHz and again with the frequency set to 18 MHz. (If 312B-H01 is available, check at 22 MHz).

- n. Set the 1 dB/step substitution attenuator to 10 dB. Adjust the 313A SCALE OFFSET for 0.0 on the 313A meter and perform the attenuator checks listed in Table 5-3.
- o. Set the 313A attenuators to 00.0 and the 1 dB/step substitution attenuator to 10. Use the 313A SCALE OFFSET controls to set the 313A meter

5-15. NON-HARMONIC DISTORTION CHECK.

- a. Interconnect the Model 313A and Model 312B as follows:

Connect the 313A
RECORDER INPUT
LOCAL OSCILLATOR INPUT
30 MHz INPUT

Table 5-3. 1 dB Step Attenuator Check.

313A ATTENUATORS	1 dB/STEP SUBSTITUTION ATTENUATOR	313A METER INDICATION
00.0	10	0.0
01.0	9	0.0 ± 0.2 dB
02.0	8	0.0 ± 0.2 dB
03.0	7	0.0 ± 0.2 dB
04.0	6	0.0 ± 0.2 dB
05.0	5	0.0 ± 0.2 dB
06.0	4	0.0 ± 0.2 dB
07.0	3	0.0 ± 0.2 dB
08.0	2	0.0 ± 0.2 dB
09.0	1	0.0 ± 0.2 dB

Table 5-4. 0.1 dB Step Attenuator Check.

313A ATTENUATORS	1 dB/Step SUBSTITUTION ATTENUATOR	313A METER INDICATION
00.0	10	0.0
00.1	10	$-0.1 \pm .02$ dB
00.2	10	$-0.2 \pm .02$ dB
00.3	10	$-0.3 \pm .02$ dB
00.4	10	$-0.4 \pm .02$ dB
00.5	10	$-0.5 \pm .02$ dB
00.6	10	$-0.6 \pm .02$ dB
00.7	10	$-0.7 \pm .02$ dB
00.8	10	$-0.8 \pm .02$ dB
00.9	10	$-0.9 \pm .02$ dB

To the 312B

RECORDER OUTPUT
LOCAL OSCILLATOR OUTPUT
30 MHz OUTPUT

- b. Set the 313A and 312B controls as follows:

312B Controls

OSCILLATOR MODE TRACK 312
METER MODE OUTPUT MONITOR
MAX OUTPUT + 10 DBM
ATTENUATORS 00.0

312A Controls

REFERENCE LEVEL . . . +10
AMPLITUDE RANGE . . . 0
FREQUENCY RANGE . . . 0
FREQUENCY 20 kHz
INPUT MODE TERMINATED,
UNBALANCED
IMPEDANCE 75
RECEIVER MODE AM

- c. Connect the output of the 313A to the input of the Model 3581A Wave Analyzer using a 75

ohm cable terminated in 75 ohms at the Wave Analyzer end of the cable.

- d. Set the 3581A controls as follows:

AMPLITUDE REFERENCE LEVEL . 0(NORMAL)
INPUT SENSITIVITY 1 VOLT
AMPLITUDE VERNIER CAL.
SCALE VOLTS
RESOLUTION BANDWIDTH 3 Hz
FREQ SPAN/DIV. 100 Hz
SWEEP MODE MAN
dBV/LIN dBV/LIN
AFC. UNLOCK

- e. Tune the 3581A FREQUENCY control for a maximum reading on the 3581A at approximately 20035 Hz. This is the fundamental frequency output of the 313A. The 3581A meter should read 0.866 V (0.707 Option 01) at the maximum. Note the 3581A frequency display reading.
- f. Tune the 3581A up 35 Hz. Adjust the 3581A Amplitude Reference Level as required for an indication on the 3581A meter.
- g. Tune the 3581A very carefully for a maximum reading on the meter. The signal 35 Hz above the fundamental frequency must be more than

- 40 dB below the fundamental frequency in step e.
- Tune the 3581A up another 35 Hz to 70 Hz above the fundamental frequency. Tune carefully for a peak on the 3581A meter. The signal 70 Hz above the fundamental frequency must be more than 40 dB below the fundamental frequency.
 - Using the above described procedure, check the signals 105, 140, 175 and 245 Hz above the fundamental frequency. These signals must be more than 40 dB below the fundamental frequency.
 - Check the signals at 35 Hz and 70 Hz below the fundamental frequency. These signals must be more than 40 dB below the fundamental frequency.
 - Check the signals at 105 Hz, 140 Hz, 175 Hz and 245 Hz below the fundamental frequency. These signals must be more than 40 dB below the fundamental frequency.
 - Using a 75 Ω feedthru, connect the 313A output to the input of the 5245L electronic counter. Set the 312A frequency to read 1000.00 kHz. The counter should read 1000.03 or 1000.04.
 - If the Non-Harmonic Distortion Check does not meet the specifications of steps e through l, refer to Paragraph 5-17 for Adjustment and Calibration procedures.
- 5-16. HARMONIC DISTORTION CHECK.**
- Connect the 313A, 3406A, 1 MHz Distortion Filter and 75 ohm feedthru termination as shown in Figure 5-5.
 - Set the 313A controls as follows:
 OSCILLATOR MODE INTERNAL
 ATTENUATORS 00.0
 MAX OUTPUT +10 DBM
 Frequency Dial 5 MHz
 - Set the 3406A to the +10 DB range and note the reading.
 - Slowly tune the 313A frequency down to 1 MHz noting the dip in the 3406A meter reading.
 - Change the 3406A RANGE switch as required and very carefully tune the 313A frequency dial for a maximum dip on the 3406A meter. This dip must be down at least 34 dB from the value noted in step c.
 - Substitute the 9.5 MHz Distortion Filter for the 1 MHz Distortion Filter in Figure 5-5.
 - Tune the 313A frequency to 5 MHz and note the reference reading on the 3406A in dB.
 - Tune the 313A frequency dial very carefully for a maximum dip at 9.5 MHz and note the reading on the 3406A. This reading must be down at least 34 dB from the reading obtained in step g.
 - Replace the 9.5 MHz Distortion Filter in Figure 5-5 with the 20.5 MHz Distortion Filter.
 - Tune the 313A frequency dial to 8 MHz and note the reference reading on the 3406A.
 - Tune the 313A frequency dial to 20.5 MHz and very carefully adjust the frequency for a maximum dip on the 3406A. The 3406A

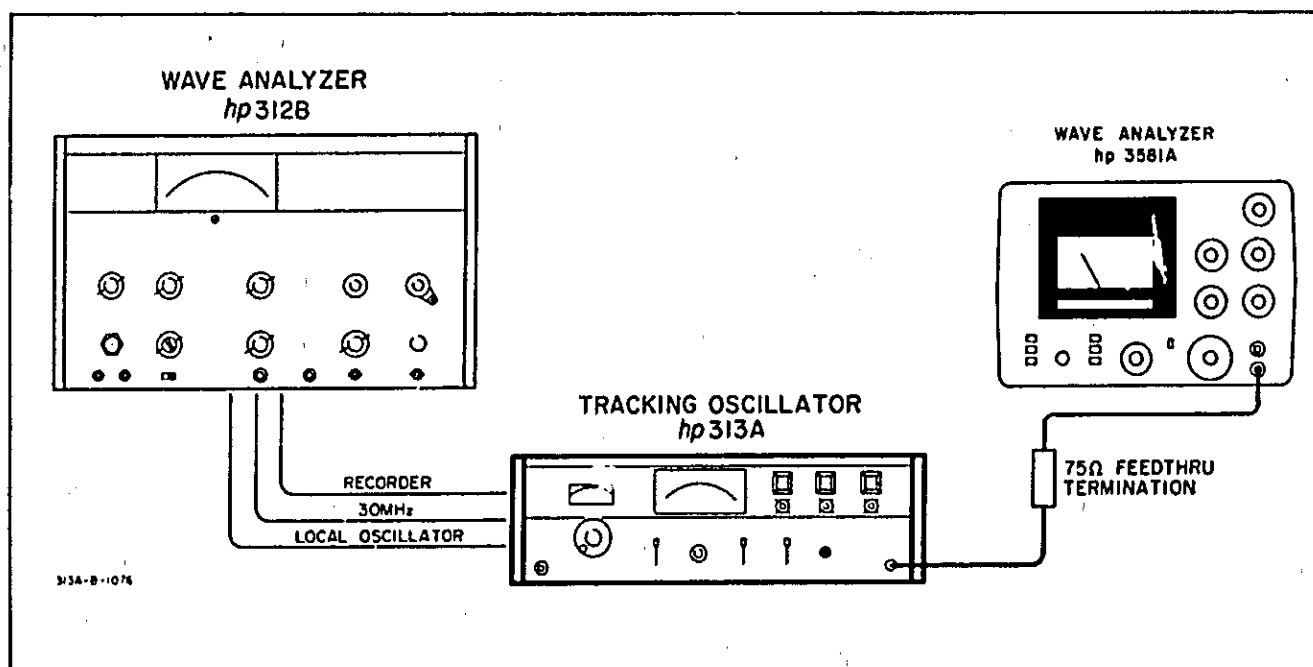


Figure 5-4. Non-Harmonic Distortion Test Setup

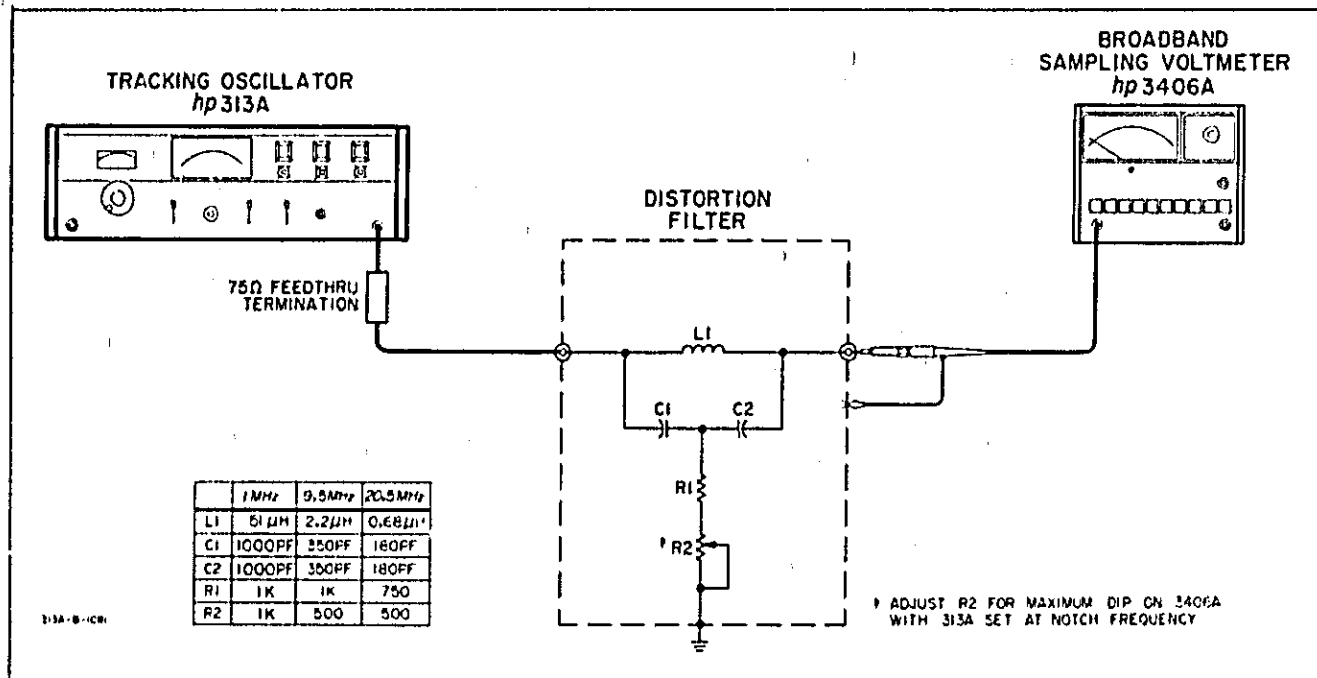


Figure 5-5. Harmonic Distortion Test Setup

reading must be down at least 34 dB from the reading obtained in step j.

A1R7 and if the voltage is too low, decrease the value of A1R7.

5-17. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-18. The following is a complete adjustment and calibration procedure for the 313A which should be performed only after it has been determined by the Performance Checks that the 313A is not within specifications. Refer to Figures 5-6 and 5-7 for location of internal adjustments.

5-19. COVER REMOVAL.

5-20. To remove the top or bottom cover, remove the retaining screws from the sides of the cover, slide the cover about 1/2 inch to the rear and lift it off. To replace the cover, reverse this procedure.

5-21. To remove the side covers, remove the retaining screws in the cover and lift it off.

5-22. POWER SUPPLY VOLTAGE ADJUSTMENT.

- Set the Model 3440A/3444A Voltmeter to the 100 V DC range and connect between pin 3 of J8 and ground.
- Turn on the Model 313A and adjust A1R15 for exactly -20 volts.
- Connect the 3440A/3444A between J8 pin 1 and ground. The positive supply must be +20 volts and ± 0.2 volts.
- If the positive supply is not within the limits specified in step c, the value of A1R7 can be changed to bring the voltage into the proper range. Change the value of A1R7 approximately 30Ω/0.1 volt of change needed. If the voltage is too high, increase the value of

5-23. INTERNAL ADJUSTMENTS.

- Connect the 313A output to the 175A/1752B oscilloscope through a 75Ω cable and a 75Ω feedthru termination.
- Set the 313A controls as follows:
 OSCILLATOR MODE . . . INTERNAL
 FREQUENCY 1 MHz
 METER MODE OUTPUT MONITOR
 MAX OUTPUT +10 DB
 ATTENUATORS 00.0
- Adjust the oscilloscope controls for 10 stable cycles in 10 cm of horizontal deflection.
- Set the Model 3440A/3444A Digital Voltmeter to the 10 V range and connect between C16 on the RF casting and ground.
- Turn on the Model 313A and adjust A4L2, A5L1 and A5L2 for maximum signal on the oscilloscope screen. The signal should be at least 2 volts peak-to-peak in amplitude.
- Readjust A5L1 and A5L2 for minimum reading on the digital voltmeter. This reading should be between +0.5 and +1.0 volts.
- Adjust the SWEEP TIME on the oscilloscope to check the waveform envelope. There should be no amplitude variations in the envelope.
- Connect a 10:1 oscilloscope probe between pin 4 of J9 and ground. The waveform should be a sine wave $0.7 \pm .1$ volt peak-to-peak in amplitude.

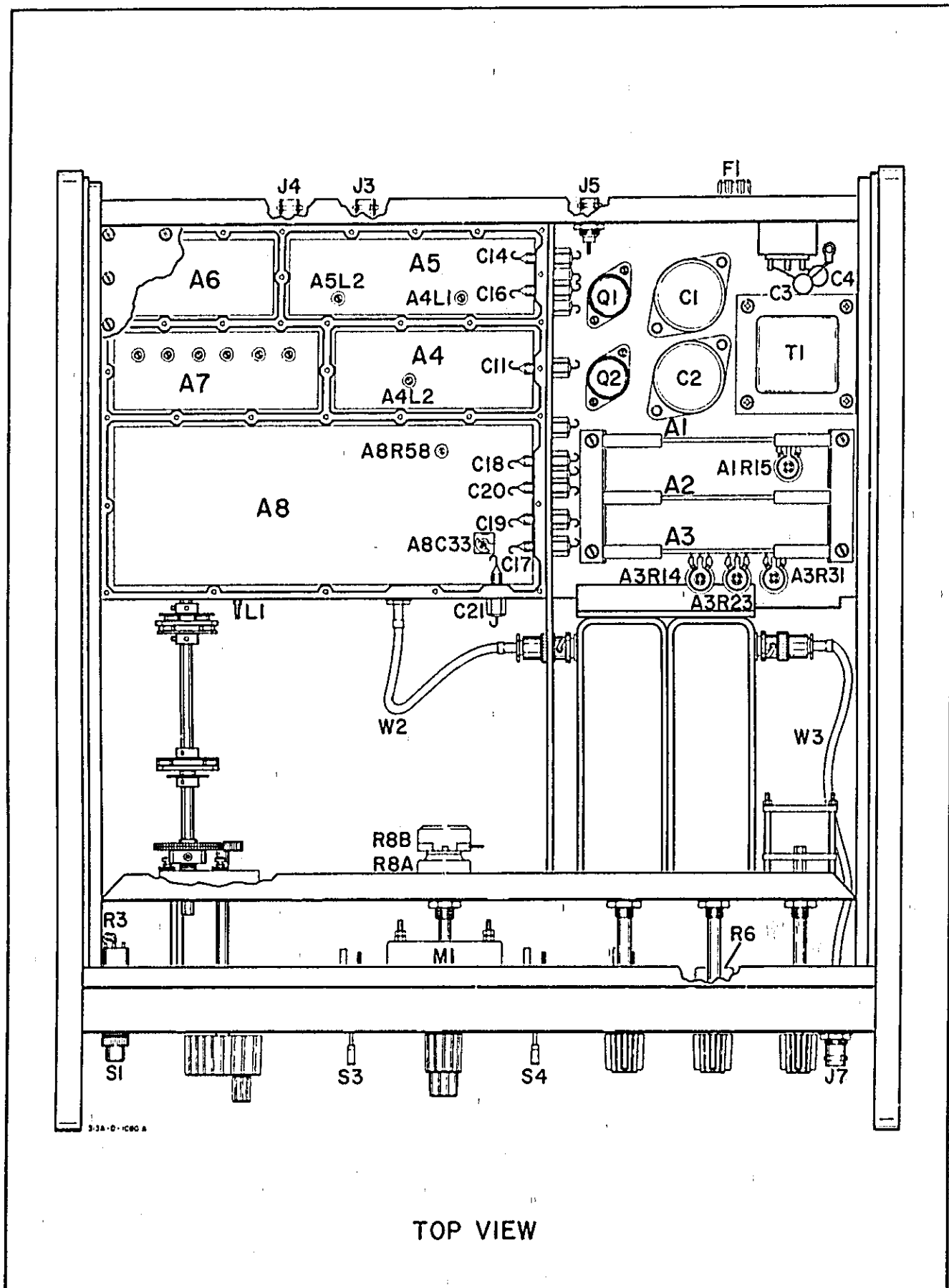


Figure 5-6. Component Location, Top View

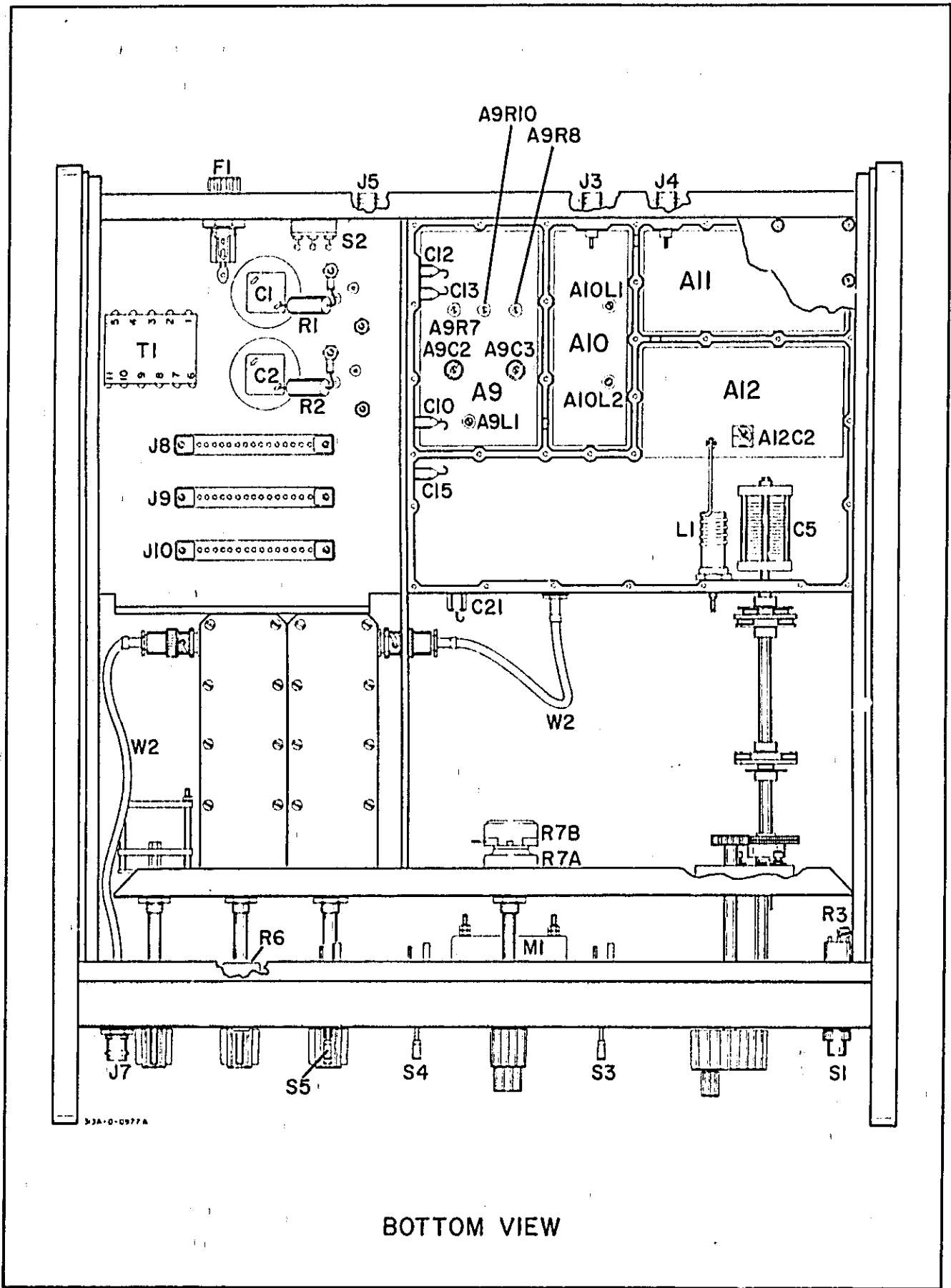


Figure 5-7. Component Location, Bottom View

- i. Connect the 10:1 oscilloscope probe to pin 13 of J9. The waveform should be 0.7 ± 0.2 V peak-to-peak in amplitude.
- j. Connect the input of 5245L counter between pin 4 of J9 and set counter to frequency. The frequency indicated on 5245L must be 35 ± 3 Hz.

5-24. OUTPUT CALIBRATION.

- a. Remove the grounding strap from the input terminals of the 3440A/3444A so that a floating measurement can be made.
- b. Set the 3440A/3444A range switch to 10 V and connect across A3TP1 and A3TP2.
- c. Adjust A3R31 (meter cal) for a reading of $1.197 \pm .002$ V on the 3440A/3444A.
- d. If A3R31 has insufficient range for the adjustment, the value of A3R26 may be changed to bring the control into the correct range. If the voltmeter reads low, lower the value of A3R26 by 1000Ω . If the voltmeter reads high, raise the value of A3R26 by 1000Ω .
- e. Connect the 3440A/3444A between A3TP3 and ground.
- f. Adjust A3R14 (AGC reference level) to obtain $5.80 \pm .01$ V on the 3440A/3444A.
- g. Set the 400F Voltmeter to the 1 V range and connect to the 313A output using RG-59B/U cable and a 75Ω feedthru termination at the voltmeter end of the cable. (Use a 50Ω termination and RG-58C/U cable for Option 01 instruments.)
- h. Adjust the 313A OUTPUT CAL control R6 so that the meter reads directly over the CAL mark on the 313A meter face.
- i. If the meter is less than full scale at full clockwise rotation of the OUTPUT CAL control, reduce the value of A3R1 by 250Ω and repeat step h. If the meter is greater than full scale at full counterclockwise rotation of the OUTPUT CAL control, raise the value of A3R1 by 250Ω and repeat step h.
- j. Adjust A8R58 (detector gain) so that the 400F reads exactly 0.866 volts. (For Option 01 instruments, adjust A8R58 for 0.707 volts.)
- k. If the 400F reads below the calibration point with A8R58 at maximum counterclockwise rotation, increase the value of A8R49 by the percentage that the output voltage is low with A8R58 centered. If the 400F reads above the calibration point with A8R58 at maximum clockwise rotation, decrease the value of A8R49 by the percentage that the output voltage is high with A8R58 centered.

5-25. FREQUENCY DIAL CALIBRATION.

- a. Connect the Model 524f electronic counter to the output of the 313A using an RG-59B/U cable and a 75Ω feedthru termination at the counter end of the cable.
- b. Set the electronic counter to read frequency.
- c. Turn the 313A frequency knob clockwise until the stop is felt.
- d. Loosen the set screws securing the dial hub to the ball drive mechanism and rotate the frequency dial until the alignment dot to the left of zero is directly under the mark in the dial window. Retighten the screws.
- e. Loosen the set screws in the straight coupler connecting the gear mechanism to the long tuning shaft.
- f. Remove the cover from the bottom of the RF casting and turn the tuning capacitor plates until they are fully meshed (maximum capacitance). Retighten the set screws using care not to disturb the previous adjustment.
- g. Turn the frequency dial until 0 appears directly under the window index marker.
- h. Adjust L1 (located on front of RF casting) to obtain a reading of less than 10 kHz on the electronic counter.
- i. Set the frequency dial to 22 MHz and adjust A12C2 to obtain a reading of $22 \text{ MHz} \pm 10 \text{ kHz}$ on the counter.
- j. Repeat steps h and i until the error at both ends of the dial is less than 10 kHz.
- k. If the frequency reads too high in step i and turning A12C2 to maximum capacitance does not bring the frequency down to 22 MHz, remove the RF casting bottom cover and increase the value of A12C1 by 5 pF. If the frequency in step i reads too low and turning A12C2 to minimum capacitance fails to bring the frequency up to 22 MHz, decrease the value of A12C1 by 5 pF. Replace the bottom cover and perform steps h and i again.
- l. Use the electronic counter to check the 313A frequency dial accuracy between 10 kHz and 22 MHz. The dial and counter must agree within the limits specified in Paragraph 5-10.

5-26. NON-HARMONIC DISTORTION ADJUSTMENT.

- a. Interconnect the 313A and 312B as follows:
 Connect the 313A
 RECORDER INPUT
 LOCAL OSCILLATOR INPUT
 30 MHz INPUT

To the 312B

RECORDER OUTPUT
LOCAL OSCILLATOR OUTPUT
30 MHz OUTPUT

- b. Set the 313A and 312B controls as follows:

313A

OSCILLATOR MODE . . . TRACK 312
METER MODE OUTPUT MONITOR
MAX OUTPUT +10 DBM
ATTENUATORS 00.0
Frequency Dial 1 MHz

312B

REFERENCE LEVEL. . . +10
AMPLITUDE RANGE. . . 0
FREQUENCY RANGE. . . 0
FREQUENCY 20 kHz
RECEIVER MODE AM

- c. Connect the 10:1 oscilloscope probe between A10TF1 and ground and adjust the oscilloscope controls for a stable presentation of the signal.
- d. Adjust A10L1 and A10L2 for maximum deflection on the oscilloscope. The minimum level should be 3 volts peak-to-peak.
- e. Connect the output of the 313A to the input terminals of the 3581A Wave Analyzer using an RG-59B/U cable terminated in 75 Ω at the 3581A end of the cable. (Use 50 Ω cable and 50 Ω termination for all Option 01 instruments.)
- f. Set the 3581A controls as follows:
- AMPLITUDE REFERENCE LEVEL . 0(NORMAL)
INPUT SENSITIVITY 1 VOLT
AMPLITUDE VERNIER CAL.
SCALE VOLTS
RESOLUTION BANDWIDTH 3 Hz
FREQ SPAN/DIV. 100 Hz
SWEEP MODE MAN
dBV/LIN dBV/LIN
AFC. UNLOCK
- g. Tune the 3581A Frequency control to approximately 20035 Hz to find the fundamental output frequency of the 313A. The 3581A meter should indicate 0.866 (+ 10 dBm) (0.707 Option 01) maximum. Note the reading on the 3581A Frequency display.
- h. Tune the 3581A up in frequency by 35 Hz.
- i. Turn the 3581A RANGE switch down as required for a display on the 3581A meter.
- j. Tune the 3581A very carefully for a maximum reading making certain that the signal monitored is 35 Hz above the frequency noted in step g.
- k. Adjust A9R7 and A9R8 (carrier balance) alternately for a minimum reading on the 3581A meter, turning down the range switch as necessary for additional sensitivity.
- l. Tune the 3581A up another 37 Hz (70 Hz above the fundamental) for maximum reading on the 3581A meter.
- m. Adjust A9R10, A9C2, A9C3 and A9L1 (side band balance) alternately for a minimum reading on the 3581A meter.
- p. Tune the 3581A 105 Hz above the fundamental frequency and measure the amplitude of the signal. The amplitude must be more than 40 dB below the fundamental frequency. If after adjustments have been made, the non-harmonic distortion check is out of tolerance, the value of A2R11 may be changed. In most cases A2R11 will have to be increased in value in order to increase the amplitude of the 35 Hz signal.
- q. Tune the 3581A 140 Hz above the fundamental frequency and measure the amplitude of the signal. The amplitude must be more than 40 dB below the fundamental frequency.
- q. Tune the 302A 140 Hz above the fundamental frequency and measure the amplitude of the signal. The amplitude must be more than 40 dB below the fundamental frequency.
- r. Check the signals at 105 Hz and 140 Hz below the fundamental frequency. These signals must also be more than 40 dB below the fundamental frequency.
- s. If the Non-Harmonic Distortion Adjustment cannot be performed to meet specifications, it may be necessary to change the value of A2R11. To select the correct value of A2R11, connect an oscilloscope to either A2 pin 4 or A2 pin 13 and change the value of A2R11 until the observed waveform on the oscilloscope is between 0.5 and 0.9 volts peak-to-peak. To increase the amplitude of this signal, increase the value of A2R11. If the value of A2R11 is changed, repeat steps a through r.
- t. Set the digital voltmeter range switch to 10 V and connect between C16 on the RF casting and ground. The meter should indicate less than +1.0 V.
- u. Connect the output of the 313A to the input of the 5245L electronic counter using a 75 Ω cable and 75 Ω termination (50 Ω cable and termination for Option 01 instruments). Set the 312B frequency to read 1000.00 kHz. The counter should indicate 10000.04 or 10000.03. If the counter reads 9999.97 or 9999.96, interchange the leads on C12 and C13 on the RF casting and repeat e through s.

5-27. METER EXPAND AND TRACKING.

- a. Connect the 313A, the Meter Expand Test Set and the 1 DB/step substitution attenuator as shown in Figure 5-1.
- b. Connect the digital voltmeter to the test point on the Meter Expand Test Set and adjust the voltage control on the test set for a reading of 1.000 volts on the digital voltmeter. Turn the substitution attenuator to 4 dB.
- c. Adjust the 313A SCALE OFFSET controls so that the 313A meter reads +1.0 dB.
- d. Turn the substitution attenuator to 6 dB. If the 313A meter reads below -1.0 dB, adjust A3R23 (expand tracking) until the meter reads as much above -1.0 as it previously read below -1.0 dB. If the 313A meter reads above -1.0 dB, adjust A3R23 until the meter reads as much below -1.0 dB as it previously read above -1.0.
- e. Turn the substitution attenuator to 4 dB and readjust the 313A SCALE OFFSET controls for a meter reading of +1.0 dB.
- f. Repeat steps b through e several times until no error exists at either end of the scale.
- g. Turn the substitution attenuator to 0 dB. Turn the 313A SCALE OFFSET Coarse control full CCW with the Fine control centered. The 313A meter should read 0.0 or less.
- h. Adjust the 313A SCALE OFFSET controls so that the 313A meter reads +1.0 dB. Turn the substitution attenuator control to 2 dB. The 313A meter should read -1.0 dB \pm 0.02 dB.
- i. Readjust the 313A SCALE OFFSET controls so that the 313A meter reads +1.0 dB and repeat steps h, through 10 dB of attenuation.
- j. Turn the 313A SCALE OFFSET Coarse Control full CW with the Fine control centered. The 313A meter must read 0.0 or greater.

5-28. FREQUENCY RESPONSE ADJUSTMENT.

- a. Connect the 313A, 312B 419A Voltmeter, H01-11050A Thermal Converter and Bucking Supply as shown in Figure 5-2.
- b. Set the 313A controls as follows:

OSCILLATOR MODE . . . TRACK 312
 METER MODE OUTPUT MONITOR
 MAX OUTPUT +10 DBM
 ATTENUATORS 00.0

- c. Set the 312B frequency to 10 kHz with the variable frequency control and the FREQUENCY RANGE switch set to 0.
- d. Set the 419A to the 10 mV range and the Bucking Supply to OFF. Push the VM button on the 419A. The 419A should read between 6 and 8 millivolts.
- e. Turn ON the Bucking Supply and adjust the controls for a null on the 419A.
- f. Turn the 419A RANGE switch to the 300 μ V range and if necessary, readjust the Bucking Supply controls for a null on the 419A.
- g. Turn the 313A 0.1 dB attenuator one step CCW and note the 419A reading. This represents 0.1 dB deviation for the following check. Return the attenuator to zero.
- h. Tune the 312B slowly between 10 kHz and 18 MHz (for H01-312A, tune between 10 kHz and 22 MHz) noting any deviations in the 419A meter. Any deviations should not exceed the value noted in step g.
- i. Switch the 313A OSCILLATOR MODE switch to INTERNAL and slowly tune the 313A from 1 kHz to 22 MHz noting any deviations on the 419A meter. Any deviations should not exceed the value recorded in step g.
- j. With the 313A frequency set to 22 MHz, adjust A8C33 (frequency response) for zero on the 419A meter and repeat steps a through i.
- k. If necessary, A8C33 may be readjusted to meet the limits of steps f and i. If A8C33 has insufficient range to meet the limits of steps f and i A8C26 may be changed. If the limits cannot be met due to A8C33 reaching its minimum capacitance setting, increase the value of A8C26 approximately 3 picofarads and again perform step f through i. If the limits cannot be reached due to A8C33 reaching minimum capacitance setting, decrease the value of A8C26 by 3 picofarads and again perform steps f through i.

NOTE

The above procedure assumes that the Thermal Converter is perfectly flat over the frequency range used. If the calibration chart accompanying the Thermal Converter shows any deviations greater than 0.25% over the frequency range of 10 kHz to 22 MHz, this deviation must be subtracted from the deviations noted in the 313A output response curve.

- l. Change the 313A attenuators to 11.1 and the output frequency to 1 MHz.
- m. Change both the 419A and bucking supply to the 1 mV range and adjust the bucking supply for a null on the 419A meter.
- n. Tune the 313A slowly from 1 MHz to 22 MHz noting any deviations on the 419A meter. Any deviations should not exceed the value noted in step g.
- o. If the 419A indication at the high end exceeds the value noted in step g increase A8C37 by 5 pF and repeat steps l through n. If the 419A indicates high decrease A8C37 by 5 pF and again perform steps l through n.
- p. Set the 313A output frequency to 1 MHz. Change the 313A 10 dB step attenuator to zero and at the same time change the MAX OUTPUT switch to 0 DBM. If necessary, readjust the bucking supply for a zero indication on the 419A meter.
- q. Tune the 313A from 1 MHz to 22 MHz, noting any deviations on the 419A meter. The 419A should not deviate more than the value noted in step g.
- r. If the 419A exceeds the value noted in step g (1% deviation) increase A8C38 to lower the

419A indication in the middle of the band and increase the value of A8R59 to bring up the response on the high end of the band.

5-29. TROUBLESHOOTING.

5-30. The following procedures are designed to aid the user in locating malfunctions in the Model 313A in a minimum of time. Included is a troubleshooting tree which, if followed in numerical sequence, should reduce the time required to isolate the malfunction to a particular block (See Figure 7-1)

5-31. It should first be determined by the Performance Checks (Paragraph 5-8) or the Adjustment and Calibration procedures (Paragraph 5-17) that a malfunction does exist. Once this has been determined, visually inspect the instrument for loose wires, burned or shorted components and possibly any foreign matter such as nuts, screws and washers that might have become trapped inside the instrument. If no defect can be found visually, continue with the following procedures.

5-32. PROCEDURE.

5-33. Since the 313A has two modes of operation, the malfunction can readily be isolated to one of three areas. Table 5-5 and Figure 5-10 will help to isolate the malfunction to a particular area.

Table 5-5. Area Troubleshooting

MODE	OUTPUT NORMAL AT J7 (0.866 V rms into 75Ω)	TROUBLE AREA
INTERNAL TRACK 312	YES NO	#1
INTERNAL TRACK 312	NO YES	#2
INTERNAL TRACK 312	NO NO	#3

AREA #1 (TRACK 312)

Delta Oscillator A2
Single Sideband Generator A9
Buffer Amplifier A10

AREA #2 (INTERNAL)

Local Oscillator A12
Crystal Oscillator A4

AREA #3

Power Supply A1
AGC Amplifier A5
Mixer A6
Low Pass Filter A7
Power Amplifier P/O A8
Average Detector P/O A8
AGC Control Amplifier P/O A3
10 dB Attenuator Pad P/O A8
Attenuators A13 and A14
Broadband Amplifier A11

Figure 5-8. Area Troubleshooting

5-34. The Troubleshooting Tree (Figure 5-10) when used in conjunction with the functional block diagram (Figure 7-3) and schematic diagrams (Figure 7-4 through 7-9) will greatly simplify troubleshooting the Model 313A. To use the troubleshooting tree, begin at ① and continue in numerical sequence according to the results (true or false) of the checks indicated on the troubleshooting tree. If any test fails refer to the schematic diagrams and utilize the voltage levels to aid in determining the cause of failure.

5-35. Check the AGC voltage at C16 on the RF casting. If the AGC voltage is abnormal (+0.5 to +1 volt is normal) disconnect the lead from C16 and substitute an external AGC voltage while troubleshooting the closed loop (See Figure 5-9). Adjust the potentiometer R1 for approximately 0.7 volts.

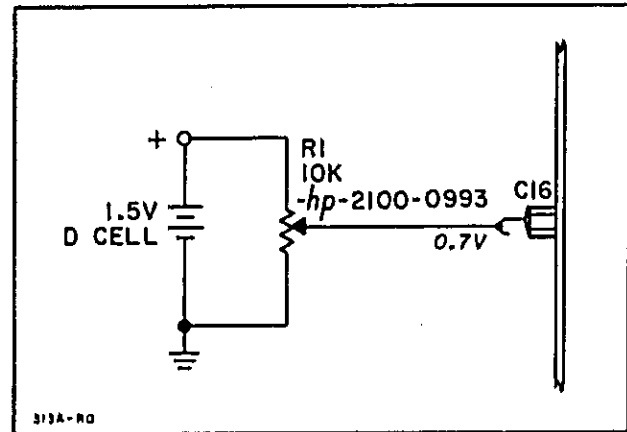


Figure 5-9. AGC Substitution Test Setup

The voltage levels indicated on this troubleshooting tree are nominal values and may vary slightly from one instrument to another. Therefore the indicated values should be used for troubleshooting purposes only and not for adjustments. Use a 10:1 oscilloscope probe to prevent loading. An oscilloscope with a pass band of at least 30 MHz should be used.

OSCILLATOR MODE	INTERNAL
METER MODE	OUTPUT MONITOR
MAX OUTPUT	+ 10 dBm
ATTENUATORS	00.0
FREQUENCY DIAL	1 MHz

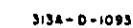


Figure 5-10. Troubleshooting Tree.
5-17/5-18.

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model: 313A
Tracking Oscillator
Serial No. _____

Tests Performed by: _____
Date _____

DESCRIPTION	CHECK
1. DIAL ACCURACY CHECK a. 1 MHz 2 MHz b. 3 MHz 4 MHz 5 MHz 6 MHz 7 MHz 8 MHz c. 9 MHz 10 MHz 11 MHz 12 MHz 13 MHz 14 MHz 15 MHz 16 MHz 17 MHz 18 MHz 19 MHz 20 MHz 21 MHz 22 MHz	_____ 1 MHz \pm 220 kHz _____ 2 MHz \pm 220 kHz _____ 3 MHz \pm 660 kHz _____ 4 MHz \pm 660 kHz _____ 5 MHz \pm 660 kHz _____ 6 MHz \pm 660 kHz _____ 7 MHz \pm 660 kHz _____ 8 MHz \pm 660 kHz _____ 9 MHz \pm 1.1 MHz _____ 10 MHz \pm 1.1 MHz _____ 11 MHz \pm 1.1 MHz _____ 12 MHz \pm 1.1 MHz _____ 13 MHz \pm 1.1 MHz _____ 14 MHz \pm 1.1 MHz _____ 15 MHz \pm 1.1 MHz _____ 16 MHz \pm 1.1 MHz _____ 17 MHz \pm 1.1 MHz _____ 18 MHz \pm 1.1 MHz _____ 19 MHz \pm 1.1 MHz _____ 20 MHz \pm 1.1 MHz _____ 21 MHz \pm 1.1 MHz _____ 22 MHz \pm 1.1 MHz
2. OUTPUT MONITOR CHECK	_____ 0.866 V \pm 0.008 V
3. METER EXPAND AND TRACKING a. +1 dB b. -1 dB	_____ +1 dB \pm 0.05 dB _____ -1 dB \pm 0.05 dB
4. OUTPUT FREQUENCY RESPONSE CHECK a. Track 312A Mode, +10 dBm b. Internal Mode, +10 dBm c. Internal Mode, 0 dBm	_____ $> \pm 0.1$ dB deviation _____ $> \pm 0.1$ dB deviation _____ $> \pm 0.1$ dB deviation
5. ATTENUATOR ACCURACY CHECK a. 10 dB Attenuator (1) 00.0 dB (2) 10.0 dB (3) 20.0 dB (4) 30.0 dB (5) 40.0 dB (6) 50.0 dB (7) 60.0 dB (8) 70.0 dB (9) 80.0 dB (10) 90.0 dB	_____ 0.0 (Reference) _____ 0.0 \pm 0.1 dB _____ 0.0 \pm 0.1 dB _____ 0.0 \pm 0.1 dB _____ 0.0 \pm 0.1 dB _____ 0.0 \pm 0.1 dB _____ 0.0 \pm 0.1 dB _____ 0.0 \pm 0.2 dB _____ 0.0 \pm 0.2 dB _____ 0.0 \pm 0.2 dB _____ 0.0 \pm 0.2 dB

PERFORMANCE CHECK TEST CARD (Cont'd)

DESCRIPTION	CHECK
5. ATTENUATOR ACCURACY CHECK (Cont'd) b. 1 dB Attenuator (1) 00.0 dB (2) 01.0 dB (3) 03.0 dB (4) 03.0 dB (5) 04.0 dB (6) 05.0 dB (7) 06.0 dB (8) 07.0 dB (9) 08.0 dB (10) 09.0 dB c. 0.1 dB Attenuator (1) 00.0 dB (2) 00.1 dB (3) 00.2 dB (4) 00.3 dB (5) 00.4 dB (6) 00.5 dB (7) 00.6 dB (8) 00.7 dB (9) 00.8 dB (10) 00.9 dB	_____ 0.0 (Reference) _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 ± 0.2 dB _____ 0.0 (Reference) _____ 0.1 ± 0.02 dB _____ 0.2 ± 0.02 dB _____ 0.3 ± 0.02 dB _____ 0.4 ± 0.02 dB _____ 0.5 ± 0.02 dB _____ 0.6 ± 0.02 dB _____ 0.7 ± 0.02 dB _____ 0.8 ± 0.02 dB _____ 0.9 ± 0.02 dB
6. NON-HARMONIC DISTORTION CHECK a. Distortion (1) 20 kHz (2) 20 kHz + 35 Hz (3) 20 kHz + 70 Hz (4) 20 kHz + 105 Hz (5) 20 kHz + 140 Hz (6) 20 kHz + 175 Hz (7) 20 kHz + 245 Hz (8) 20 kHz - 35 Hz (9) 20 kHz - 70 Hz (10) 20 kHz - 105 Hz (11) 20 kHz - 140 Hz (12) 20 kHz - 175 Hz (13) 20 kHz - 245 Hz b. 312A Tuning 1000.00 kHz	_____ (Reference) _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ Down > 40 dB _____ 1000.03 or 1000.04 _____ Counter Indication
7. HARMONIC DISTORTION CHECK a. Tuning 1 MHz b. Tuning 9.5 MHz c. Tuning 20.5 MHz	_____ Down > 34 dB _____ Down > 34 dB _____ Down > 34 dB

PARTS LIST

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphabetic order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

- a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.
- b. Description of the part. (See list of abbreviations below.)
- c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)
- d. Manufacturer's part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

DESIGNATORS

A	= assembly	F	= fuse	NP	= mechanical part	TC	= thermocouple
B	= motor	FL	= filter	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
BT	= battery	HR	= heater	Q	= transistor	W	= cable
C	= capacitor	IC	= integrated circuit	QCR	= transistor-diode	X	= socket
CR	= diode	J	= jack	R	= resistor	XDS	= lampholder
DL	= delay line	K	= relay	RT	= thermistor	XF	= fuseholder
DS	= lamp	L	= inductor	S	= switch	Z	= network
E	= misc electronic part	M	= meter	T	= transformer		

ABBREVIATIONS

Ag	= silver	ID	= inside diameter	ns	= nanosecond (s) = 10^{-9} seconds	sl	= slide
Al	= aluminum	Impg	= impregnated	nsr	= not separately replaceable	SPDT	= single-pole double-throw
A	= ampere (s)	Inc	= incandescent			SPST	= single-pole single-throw
Au	= gold	Ins	= insulation (ed)				
C	= capacitor	k Ω	= kilohm (s) = 10^3 ohms	Ω	= ohm (s)	Ta	= tantalum
cer	= ceramic	kHz	= kilohertz = 10^3 hertz	obd	= order by description	TC	= temperature coefficient
coef	= coefficient	L	= inductor	OD	= outside diameter	TiO ₂	= titanium dioxide
com	= common	lin	= linear taper	p	= peak	tol	= tolerance
comp	= composition	log	= logarithmic taper	pc	= printed circuit	trim	= trimmer
conn	= connection	m	= milli = 10^{-3}	pF	= picofarad (s) = 10^{-12} farads	TSTR	= transistor
dep	= deposited	mA	= milliamperes (s) = 10^{-3} amperes	piv	= peak inverse voltage	V	= volt (s)
DPDT	= double-pole double-throw	MHz	= megahertz = 10^6 hertz	p/o	= part of	vacw	= alternating current working voltage
DPST	= double-pole single-throw	M Ω	= megohm (s) = 10^6 ohms	pos	= position (s)	var	= variable
elect	= electrolytic	met film	= metal film	poly	= polystyrene	vdw	= direct current working voltage
encap	= encapsulated	mfr	= manufacturer	pot	= potentiometer		
F	= farad (s)	mtg	= mounting	p-p	= peak-to-peak	W	= watt (s)
FET	= field effect transistor	mV	= millivolt (s) = 10^{-3} volts	ppm	= parts per million	w/	= with
fxd	= fixed	μ	= micro = 10^{-6}	prec	= precision (temperature coefficient, long term stability, and/or tolerance)	wiv	= working inverse voltage
GaAs	= gallium arsenide	μ V	= microvolt (s) = 10^{-6} volts			w/o	= without
GHz	= gigahertz = 10^9 hertz	my	= Mylar [®]			ww	= wirewound
gd	= guard (ed)	nA	= nanoampere (s) = 10^{-9} amperes	R	= resistor	*	= optimum value selected at factory, average value shown (part may be omitted)
Ge	= germanium	NC	= normally closed	Rh	= rhodium	**	= no standard type number assigned (selected or special type)
grd	= ground (ed)	Ne	= neon	rms	= root-mean-square		
H	= henry (ies)	NO	= normally open	rot	= rotary		
Hg	= mercury	NPO	= negative positive zero (zero temperature coefficient)	Se	= selenium		
Hz	= hertz (cycle (s) per second)			sect	= section (s)		
				Si	= silicon		

[®] Dupont de Nemours

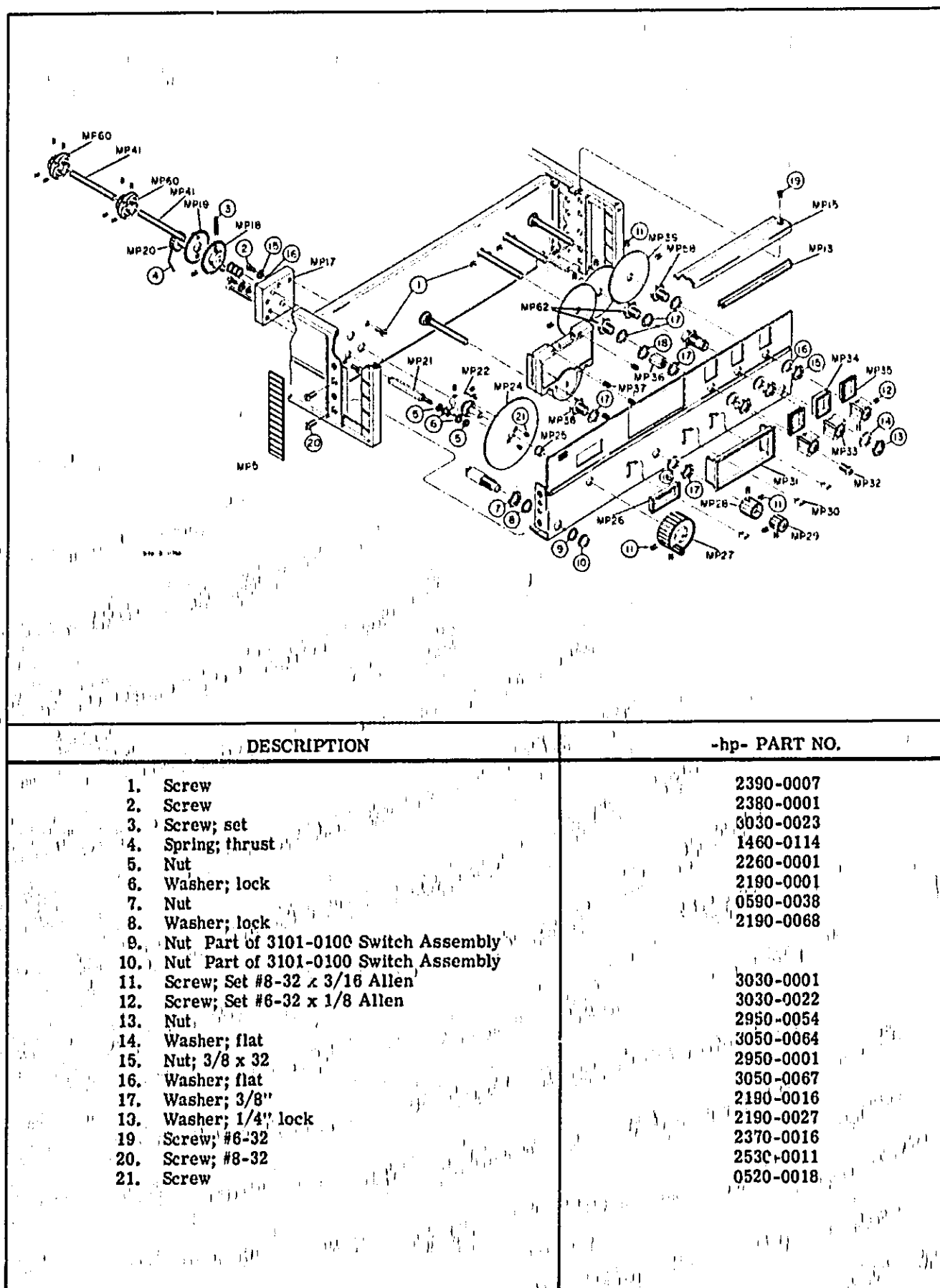


Figure 6-1. Attaching Hardware

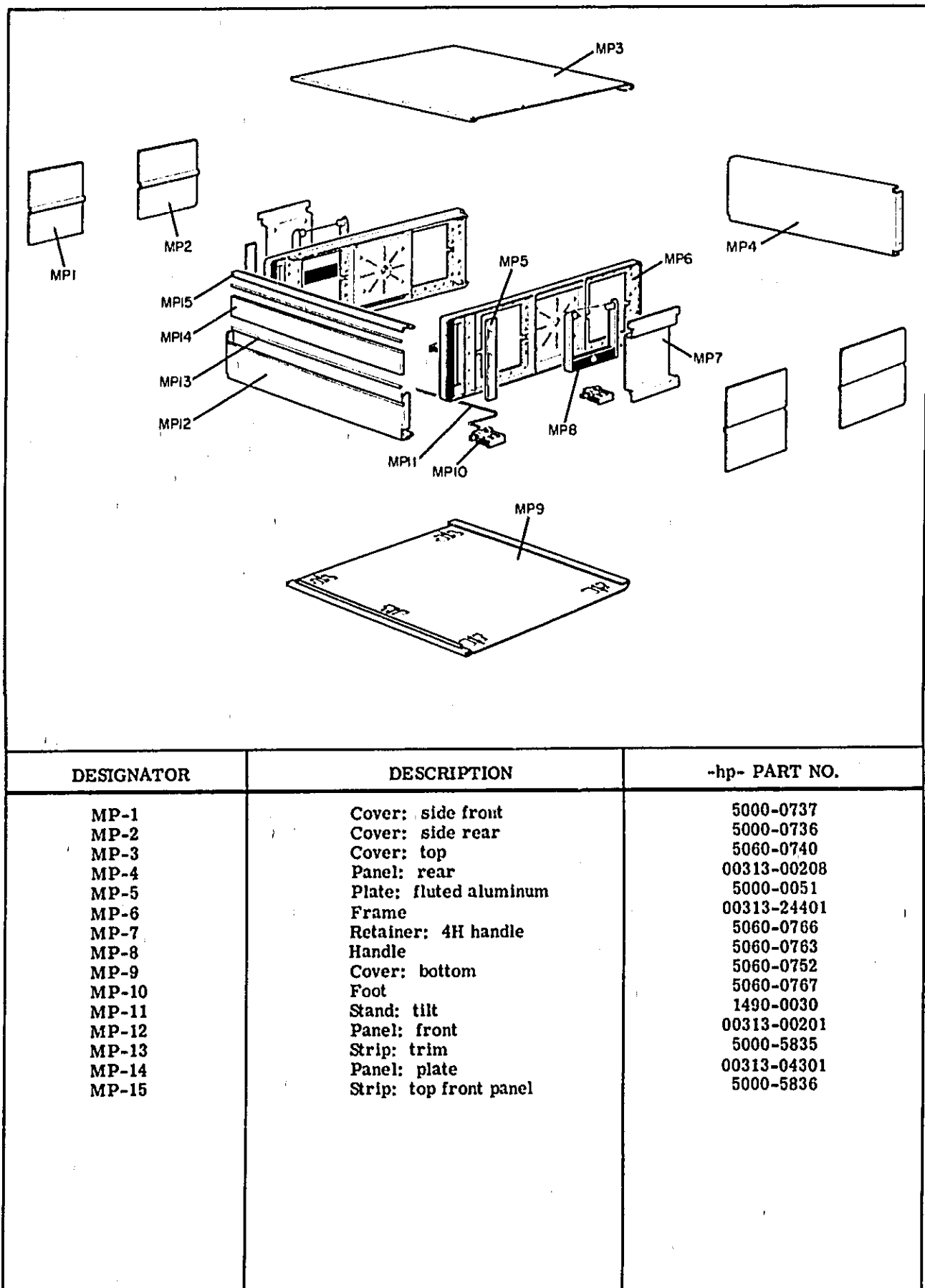
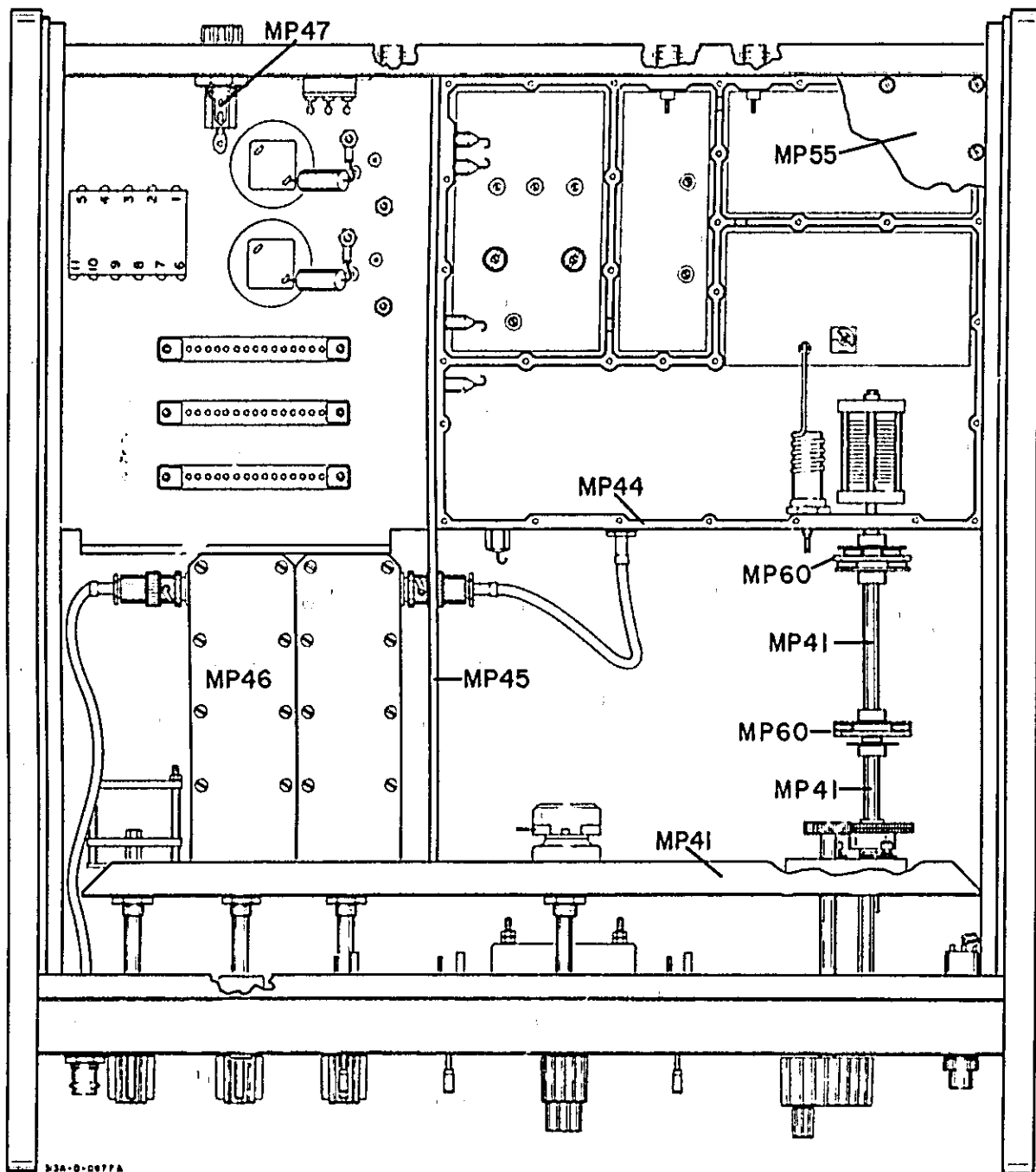
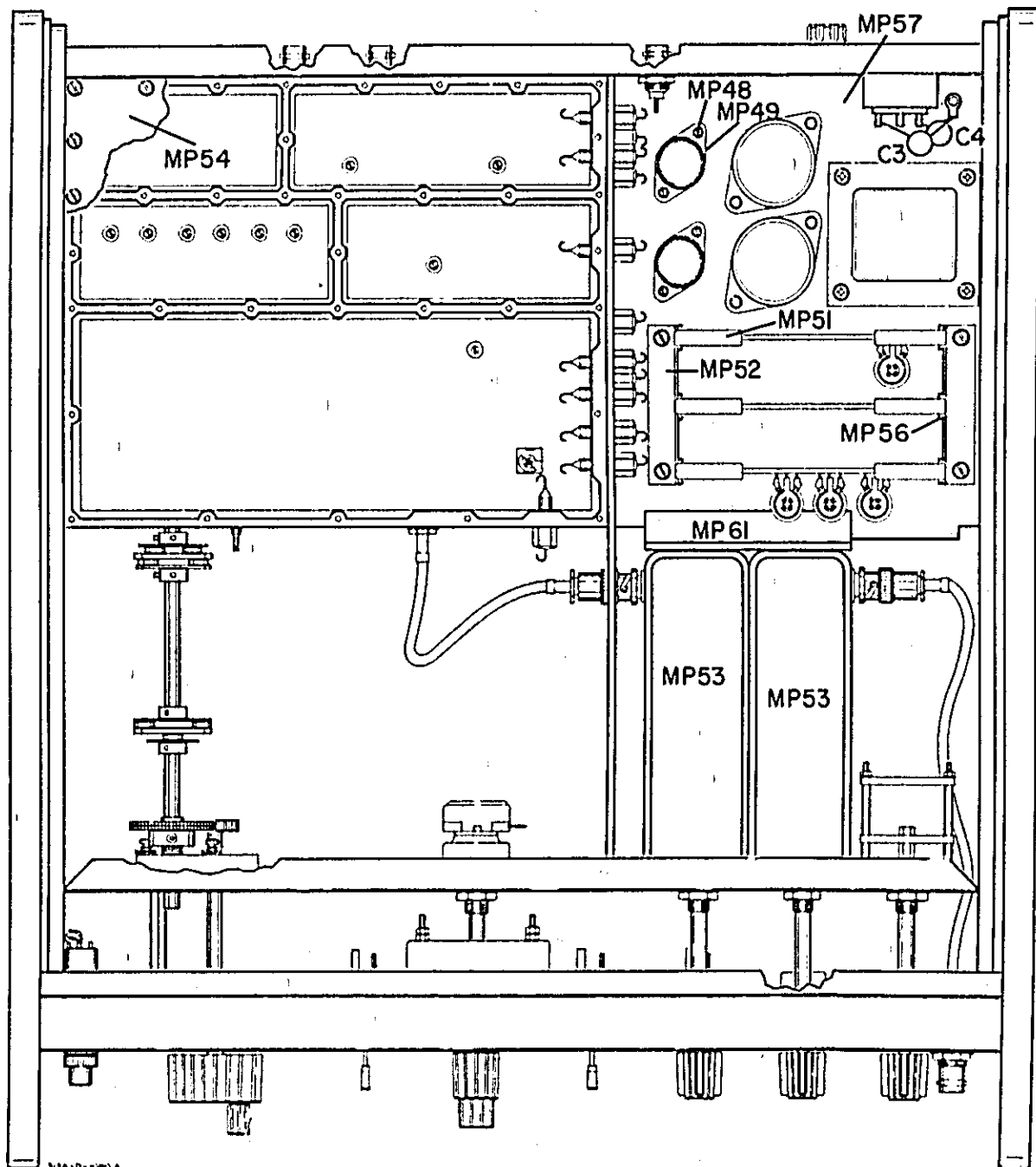


Figure 6-2. Chassis and Cover Component Identification



BOTTOM VIEW

Figure 6-3. Mechanical Parts Location



TOP VIEW

Figure 6-4. Mechanical Parts Location

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1			POWER SUPPLY ASSEMBLY.		
	00313-66501	1	PC Board Assembly	-hp-	
	1480-0116	2	Rollpin: steel plain	84396	59-032-156-1000
	5040-1464	2	Extractor	-hp-	
C1	0180-0149	4	C: fxd Al elect 65 μ F +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
C2	0150-0093	41	C: fxd cer 0.01 μ F +80% -20% 100 vdcw	91418	TA obd
C3	0180-0149		C: fxd Al elect 65 μ F +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
C4	0180-0045	2	C: fxd Al elect 20 μ F +75% -10% 25 vdcw	56289	30D206G025CB2-DSM
C5	0180-0149		C: fxd Al elect 65 μ F +100% -10% 60 vdcw	56289	Type 30D D36987-DSM
C6	0150-0093		C: fxd cer 0.01 μ F +80% -20% 100 vdcw	91418	TA obd
C7	0180-0045		C: fxd Al elect 20 μ F +75% -10% 25 vdcw	56289	30D206G025CB2-DSM
C8	0180-0149		C: fxd Al elect 65 μ F +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
CR1 thru CR4	1901-0158	4	Diode: pwr rect 200 V	04713	SR 1358-3
CR5	1901-0025	1	Diode: Si 100 piv 12 pF 100 mA	04651	D3072
CR6	1902-0048	1	Diode: breakdown zener 6.81 V \pm 5% 400 mW	04713	SZ10939-134
Q1 thru Q4	1854-0215	8	TSTR: Si NPN 2N3904	04713	obd
R1	0686-5115	2	R: fxd comp 510 Ω \pm 5% 1/2 W	01121	EB 5115
R2, R3	0683-5125	4	R: fxd comp 5100 Ω \pm 5% 1/4 W	01121	CB 5125
R4	0683-5625	2	R: fxd comp 5600 Ω \pm 5% 1/4 W	01121	CB 5625
R5	0698-3515	1	R: fxd met flm 5900 Ω \pm 1% 1/8 W	19701	MF5C T-O obd
R6	0698-3497	1	R: fxd met flm 6040 Ω \pm 1% 1/8 W	19701	MF5C T-O obd
R7*	0698-3442	1	R: fxd met flm 237 Ω \pm 1% 1/8 W	75042	CEA T-O obd
R8, R9	0683-5125		R: fxd comp 5100 Ω \pm 5% 1/4 W	01121	CB 5125
R10	0686-5115		R: fxd comp 510 Ω \pm 5% 1/2 W	01121	EB 5115
R11	0683-5625		R: fxd comp 5600 Ω \pm 5% 1/4 W	01121	CB 5625
R12	0683-3925	1	R: fxd comp 3900 Ω \pm 5% 1/4 W	01121	CB 3925
R13	0757-0437	1	R: fxd met flm 4750 Ω \pm 1% 1/8 W	19701	MF5C T-O obd
R14	0698-3226	1	R: fxd met flm 6490 Ω \pm 1% 1/8 W	19701	MF5C T-O obd
R15	2100-0962	2	R: var comp lin 3000 Ω \pm 30% 1/4 W	09569	MTC-1
A2			DELTA OSCILLATOR ASSEMBLY.		
	00313-66502	1	PC Board Assembly	-hp-	
	1480-0116	2	Rollpin: steel plain	84396	59-032-156-1000
	5040-1464	2	Extractor	-hp-	
C1	0180-0101	2	C: fxd Ta elect 1.8 μ F \pm 10% 20 vdcw	56289	150D225X9020A2-DYS
C2	0180-1800	2	C: fxd Al elect 100 μ F +100% -10% 6 vdcw	56289	30D603 DSM
C3	0180-0101		C: fxd Ta elect 1.8 μ F \pm 10% 20 vdcw	56289	150D225X9020A2-DYS
C4	0180-1800		C: fxd Al elect 100 μ F +100% -10% 6 vdcw	56289	30D603 DSM
C5	0150-0093		C: fxd cer 0.01 μ F +80% -20% 100 vdcw	91418	TA obd
C6	0180-0294	1	C: fxd Ta elect 390 μ F \pm 20% 10 vdcw	56289	109D397X0010T2
DS1	2140-0248	1	Lamp: incandescent	24446	7344 obd
Q1	1853-0036	5	TSTR: Si PNP 2N3906	04713	2N3906-18
Q2	1854-0215	2	TSTR: Si PNP 2N3904	07263	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)					
Q3	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-18
Q4	1854-0215		TSTR: Si PNP 2N3904	07263	obd
Q5	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-18
R1, R2	0683-2425	5	R: fxd comp 2400Ω ±5% 1/4 W	01121	CB 2425
R3	0698-3492	2	R: fxd met flm 2670Ω ±1% 1/8 W	75042	CEA T-O obd
R4	0683-1025	16	R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R5	0683-5115	9	R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R6, R7	0683-2425	5	R: fxd comp 2400Ω ±5% 1/4 W	01121	CB 2425
R8	0698-3492		R: fxd met flm 2670Ω ±1% 1/8 W	01637	obd
R9	0683-1025		R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R10	0683-5115		R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R11*	0683-5615	2	R: fxd comp 560Ω ±5% 1/4 W	01121	CB 5615
R12	0686-1825	1	R: fxd comp 1800Ω ±5% 1/2 W	01121	EB 1825
R13, R14	0683-1035	7	R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A3					
METER EXPAND AMPLIFIER AND AGC CONTROL AMPLIFIER ASSEMBLY.					
C1, C2	00313-66503 0150-0093	1	PC Board Assembly C: fxd cer 0.01 μF +80% -20% 100 vdcw	-hp- 56289	Type 30D D36978-DSM
C3	0180-0393	5	C: fxd Ta elect 39 μF ±5% 10 vdcw	56289	150D406X5010B2-DYS
	5040-1464	2	Extractor	-hp- 84396	59-032-156-1000
	1480-0116	2	Rollpin: steel plain		
C4	0140-0190	1	C: fxd mica 39 pF ±5%	04062	RDM15E390J3C
C5	0160-0302	1	C: fxd my 0.018 μF ±10% 200 vdcw	56289	192P18392-PTS
C6	0180-0376	1	C: fxd Ta elect 0.47 μF ±10% 35 vdcw	56289	150D474X9035A2-DYS
CR1	1902-0018	1	Diode: breakdown zener 11.7 V ±5%	04713	obd
Q1 thru Q4	1854-0033	10	TSTR: Si NPN 2N3391	24446	2N3391
Q5	1853-0036	2	TSTR: Si PNP 2N3906	04713	2N3906-18
Q6	1854-0033		TSTR: Si NPN 2N3391	24446	2N3391
Q7	1854-0215		TSTR: Si PNP 2N3904	04713	2N3904
Q8	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-18
Q9 thru Q13	1854-0033		TSTR: Si NPN 2N3391	24446	2N3391
R1*	0698-4020		R: fxd met flm 9.53 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R2	0757-0482		R: fxd met flm 511 kΩ ±1% 1/8 W	75042	CEA T-O obd
R3	0698-3557	1	R: fxd met flm 806Ω ±1% 1/8 W	75042	CEA T-O obd
R4	0757-0200	1	R: fxd met flm 5620Ω ±1% 1/8 W	19701	MF5C T-O obd
R5	0757-0465	2	R: fxd met flm 100 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R6	0757-0280	6	R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
R7	0757-0465		R: fxd met flm 100 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R8	0683-6825	2	R: fxd comp 6800Ω ±5% 1/4 W	01121	CB 6825
R9	0757-0280		R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
R10	0698-3260	1	R: fxd met flm 464 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R11	0698-3162	1	R: fxd met flm 46.4 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R12	0757-0288	2	R: fxd met flm 9090Ω ±1% 1/8 W	75042	CEA T-O obd
R13	0698-4429	1	R: fxd met flm 1970Ω ±1% 1/8 W	75042	CEA T-O obd
R14	2100-0909	2	R: var comp lin 100Ω ±30% 1/4 W	37942	MTC-1 obd
R15	0757-0420	3	R: fxd met flm 750Ω ±1% 1/8 W	75042	CEA T-O obd
R16	0757-0440	2	R: fxd met flm 7500Ω ±1% 1/8 W	19701	MF5C T-O obd
R17	0757-0441	1	R: fxd met flm 8250Ω ±1% 1/8 W	19701	MF5C T-O obd
R18	0757-0440		R: fxd met flm 7500Ω ±1% 1/8 W	19701	MF5C T-O obd
R19	0757-0482		R: fxd met flm 511 kΩ ±1% 1/8 W	75042	CEA T-O obd
R20	0757-0276	1	R: fxd met flm 61.9Ω ±1% 1/8 W	75042	CEA T-O obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3 (Cont'd)					
R21, R22	0757-0427	2	R: fxd met flm 1.5 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R23	2100-0909		R: var comp lin 100 Ω $\pm 30\%$ 1/4 W	37942	MTC-1 obd
R24	0698-4421	1	R: fxd met flm 249 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R25	0698-3155	1	R: fxd met flm 4640 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R26*	0757-0288		R: fxd met flm 9090 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R27	0698-4055	1	R: fxd met flm 1000 Ω $\pm 1/4\%$ 1/8 W	19701	MF5C T-O obd
R28	0757-0199	1	R: fxd met flm 21.5k Ω $\pm 1\%$ 1/8 W	19701	MF5C T-O obd
R29	0757-0439	1	R: fxd met flm 6810 Ω $\pm 1\%$ 1/8 W	10701	MF5C T-O obd
R30	0757-0280		R: fxd met flm 1000 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R31	2100-0908		R: var comp lin 2000 Ω $\pm 30\%$ 1/4 W	37942	MTC-1 obd
R32, R33	0757-0465		R: fxd met flm 100 k Ω $\pm 1\%$ 1/8 W	19701	MF5C T-O obd
A4					
	00313-66504	1	PC Board Assembly	-hp-	
C1	0160-0763	1	C: fxd mica 5 pF $\pm 10\%$	04062	RDM150C050K5S
C2, C3	0150-0093	2	C: fxd 0.01 μ F $\pm 80\%$ -20% 100 vdcw	91418	TA obd
C4	0140-0196	3	C: fxd mica 150 pF $\pm 5\%$	04062	RDM15F151J3C
C5	0140-0178	2	C: fxd mica 560 pF $\pm 2\%$	04062	RDM15F751J3S
L1	9140-0047	1	Choke: R. F. 20 μ H $\pm 10\%$	99848	H51074020
L2	9100-1366	1	Coil: Inductor var 5-1/2 turns	-hp-	
Q1	1854-0057	1	TSTR: 2N3855	24446	obd
R1, R2	0683-2035	8	R: fxd comp 20 k Ω $\pm 5\%$ 1/4 W	01121	CB 2035
R3	0683-1035		R: fxd comp 10 k Ω $\pm 5\%$ 1/4 W	01121	CB 1035
R4	0683-1525	1	R: fxd comp 1500 Ω $\pm 5\%$ 1/4 W	01121	CB 1525
Y1	0410-0137	1	Crystal Quartz: 30 MHz $\pm 0.001\%$ Third Overtone	91418	HP0030
A5					
	00313-66505	1	PC Board Assembly	-hp-	
C1	0160-0938	2	C: fxd mica 1000 pF $\pm 5\%$	00853	RDM15E102J1C
C2, C3	0150-0093		C: fxd cer 0.01 μ F $\pm 80\%$ -20% 100 vdcw	91418	TA obd
C4	0140-0196		C: fxd mica 150 pF $\pm 5\%$	04062	RDM15F151J3C
C5	0160-2035		C: fxd mica 750 pF $\pm 5\%$ 300 V	14655	RDM15F391J3C
C6	0150-0029	1	C: fxd TiO ₂ 1 pF $\pm 10\%$ 500 vdcw	78488	Type GA obd
C7	0160-0938		C: fxd mica 1000 pF $\pm 5\%$	00853	RDM15E102J1C
C8, C9	0150-0093		C: fxd cer 0.01 μ F $\pm 80\%$ -20% 100 vdcw	91418	TA obd
C10	0140-0196		C: fxd mica 150 pF $\pm 5\%$	04062	RDM15F151J3C
C11	0160-2035	2	C: fxd mica 750 pF $\pm 5\%$ 300 V	04062	RDM15F751J3S
CR1, CR2	1901-0347	2	Diode: schottky 8 V	-hp-	
L1, L2	9100-1366		Coil: Inductor var 5-1/2 turns	-hp-	
Q1, Q2	1854-0219	12	TSTR: Si NPN 2N3663	24446	obd
R1, R2	0683-2035	4	R: fxd comp 20 k Ω $\pm 5\%$ 1/4 W	01121	CB 2035
R3	0683-3325	2	R: fxd comp 3300 Ω $\pm 5\%$ 1/4 W	01121	CB 3325
R4	0757-0283	1	R: fxd met flm 2000 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R5	0757-0277		R: fxd met flm 49.9 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
R6, R7	0683-2035	4	R: fxd comp 20 k Ω $\pm 5\%$ 1/4 W	01121	CB 2035
R8	0683-3325	2	R: fxd comp 3300 Ω $\pm 5\%$ 1/4 W	01121	CB 3325
T1, T2	9100-1361	2	Transformer: Trifilar core	-hp-	

Table 6-1, Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A6			OUTPUT MIXER ASSEMBLY.		
	00313-66506	1	PC Board Assembly	-hp-	
CR1 thru CR4	1010-0022	6	Diode: Ge 5 wiv 3.5 ns	93332	obd
R1	0698-4397	1	R: fxd met flm 84.5Ω ±1% 1/8 W	75042	CEA T-O obd
R2	0698-4415	1	R: fxd met flm 165Ω ±1% 1/8 W	75042	CEA T-O obd
R3 thru R6	0698-3444	4	R: fxd met flm 316Ω ±1% 1/8 W	75042	CEA T-O obd
T1, T2	0100-1361		Transformer: Trifilar core	-hp-	
A7			LOW PASS FILTER ASSEMBLY.		
	00313-66507	1	PC Board Assembly	-hp-	
C1	0160-2646	2	C: fxd mica 168.0 pF ±1%	04062	RDM15F(168.0)F3C
C2	0160-2647	2	C: fxd mica 302.4 pF ±1%	04062	RDM15F(302.4)F3C
C3	0160-2644	2	C: fxd mica 315.2 pF ±1%	04062	RDM15F(315.2)F3C
C4	0160-2645	1	C: fxd mica 317.3 pF ±1%	04062	RDM15F(317.3)F3C
C5	0160-2644		C: fxd mica 315.2 pF ±1%	04062	RDM15F(315.2)F3C
C6	0160-2647		C: fxd mica 302.4 pF ±1%	04062	RDM15F(302.4)F3C
C7	0160-2646		C: fxd mica 168.0 pF ±1%	04062	RDM15F(168.0)F3C
L1	9100-1363	2	Coil: Inductor preset 0.5096 μH	-hp-	
L2	9100-1364	2	Coil: Inductor preset 0.5740 μH	-hp-	
L3, L4	9100-1365	2	Coil: Inductor preset 0.5841 μH	-hp-	
L5	9100-1364		Coil: Inductor preset 0.5740 μH	-hp-	
L6	9100-1363		Coil: Inductor preset 0.5096 μH	-hp-	
A8			POWER AMPLIFIER AND DETECTOR ASSEMBLY.		
	00313-66508	1	PC Board Assembly	-hp-	
C1	0180-0155	11	C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C2	0140-0199	1	C: fxd mica 240 pF ±5%	04062	RDM15F241J3C
C3 thru C7	0180-0155		C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C8	0180-0116	7	C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C9	0150-0093	5	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C10	0160-0170	24	C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C11	0180-0155		C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C12 thru C16	0160-0170		C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C17	0180-0116		C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C18, C19	0150-0093		C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C20	0180-0116		C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C21	0160-0170		C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C22	0160-0127		C: fxd cer 1.0 μF ±20% 25 vdcw	56289	5C13C obd
C23	0180-0116		C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C24, C25	0150-0093		C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C26*	0140-0201	2	C: fxd mica 12 pF ±5%	72136	RDM15C120J5C
C27	0150-0115	2	C: fxd cer 27 pF ±10% 500 vdcw	72982	301-C00-U2JO-270K
C28, C29	0180-0116		C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A8 (Cont'd)					
C30	0160-0170		C: fxd cer 0.22 μ F $\pm 80\%$ -20% 25 vdcw	56289	5C0B obd
C31	0180-0116		C: fxd Ta elect 6.8 μ F $\pm 10\%$ 35 vdcw	56289	150D085X0035B2-DYS
C32	0180-0155		C: fxd Ta elect 2.2 μ F $\pm 20\%$ 20 vdcw	56289	150D225X0020A2-DYS
C33	0121-0128	3	C: var air trimmer 1.4-7.3 pF on schematic	74970	189-505-5
C34	0180-0155		C: fxd Ta elect 2.2 μ F $\pm 20\%$ 20 vdcw	56289	150D225X0020A2-DYS
C35, C36	0180-0354		C: fxd Ta elect 40 μ F $\pm 5\%$ 10 vdcw	56289	150D40 X5010B2-DYS
C37*	0160-2198		C: fxd 20 pF 300 vdcw	28480	0160-2198
C38*	0140-0202		C: fxd mica 15 pF $\pm 5\%$	04062	RDM15C150J5C
C39	0150-0093		C: fxd 0.01 μ F $\pm 80\%$ -20% 100 vdcw	91418	TA obd
C40	0180-0155		C: fxd 2.2 μ F 20 vdc	56289	150D225X0020A2
CRI, CR2	5080-9043		Diode: Ge selected	73293	HPS1672
K1, K2	0490-0399	2	Relay Reed assembly: 12 Vdc 1200 Ω	-hp-	
L1, L2	9140-0098	2	Coil: Inductor var 10-1/2 turns 2.2 μ H	-hp-	
L3	9140-0047		Choke: RF 20 μ H $\pm 10\%$ 2.5 MHz	99848	H51074020
Q1 thru Q3	1854-0210		TSTR: SI NPN 2N3663	24446	obd
Q4	1854-0254	4	TSTR: SI NPN 2N2218	04713	SS2184-2
Q5 thru Q7	1854-0233	4	TSTR: SI NPN 2N3866	07235	obd
Q8 thru Q12	1853-0010	10	TSTR: PNP SI	-hp-	1853-0010
Q13, Q14	1854-0092	4	TSTR: SI NPN 2N3563	04713	MPS 3563
R1	0757-0388	2	R: fxd met flm 30.1 Ω $\pm 1\%$ 1/8 W	19701	MF5C T-O obd
R2	0698-3439	2	R: fxd met flm 178 Ω $\pm 1\%$ 1/8 W	19701	MF5C T-O obd
R3	0757-0392	2	R: fxd met flm 43.2 Ω $\pm 1\%$ 1/8 W	19701	MF5C T-O obd
R4	0683-1035	2	R: fxd comp 10 k Ω $\pm 5\%$ 1/4 W	01121	CB 1035
R5	0683-2025	2	R: fxd comp 2000 Ω $\pm 5\%$ 1/4 W	01121	CB 2025
R6	0683-3015	5	R: fxd comp 300 Ω $\pm 5\%$ 1/4 W	01121	CB 3015
R7	0683-3315	1	R: fxd comp 330 Ω $\pm 5\%$ 1/4 W	01121	CB 3315
R8	0683-0685		R: fxd comp 6.8 Ω $\pm 5\%$ 1/4 W	01121	CB 68G5
R9	0683-3015		R: fxd comp 300 Ω $\pm 5\%$ 1/4 W	01121	CB 3015
R10	0683-5115	6	R: fxd comp 510 Ω $\pm 5\%$ 1/4 W	01121	CB 5115
R11	0683-0685	3	R: fxd comp 6.8 Ω $\pm 5\%$ 1/4 W	01121	CB 68G5
R12	0683-3015		R: fxd comp 300 Ω $\pm 5\%$ 1/4 W	01121	CB 3015
R13	0683-0685		R: fxd comp 6.8 Ω $\pm 5\%$ 1/4 W	01121	CB 68G5
R14	0683-3015		R: fxd comp 300 Ω $\pm 5\%$ 1/4 W	01121	CB 3015
R15	0683-0825	2	R: fxd comp 8.2 Ω $\pm 5\%$ 1/4 W	01121	CB 82G5
R16	0683-3015		R: fxd comp 300 Ω $\pm 5\%$ 1/4 W	01121	CB 3015
R17	0683-0825		R: fxd comp 8.2 Ω $\pm 5\%$ 1/4 W	01121	CB 82G5
R18	0698-3634	2	R: fxd met oxide 470 Ω $\pm 5\%$ 2 W	07115	C42S obd
R19	0683-1035		R: fxd comp 10 k Ω $\pm 5\%$ 1/4 W	01121	CB 1035
R20	0683-1015	2	R: fxd comp 100 Ω $\pm 5\%$ 1/4 W	01121	CB 1015
R21	0683-1025	12	R: fxd comp 1000 Ω $\pm 5\%$ 1/4 W	01121	CB 1025
R22	0683-5115		R: fxd comp 510 Ω $\pm 5\%$ 1/4 W	01121	CB 5115
R23	0683-2725	2	R: fxd comp 2700 Ω $\pm 5\%$ 1/4 W	01121	CB 2725
R24, R25	0683-1025		R: fxd comp 1000 Ω $\pm 5\%$ 1/4 W	01121	CB 1025
R26	0683-5115		R: fxd comp 510 Ω $\pm 5\%$ 1/4 W	01121	CB 5115
R27	0683-2725		R: fxd comp 2700 Ω $\pm 5\%$ 1/4 W	01121	CB 2725
R28, R29	0683-1025		R: fxd comp 1000 Ω $\pm 5\%$ 1/4 W	01121	CB 1025
R30	0683-5115		R: fxd comp 510 Ω $\pm 5\%$ 1/4 W	01121	CB 5115
R31	0686-9115	2	R: fxd comp 910 Ω $\pm 5\%$ 1/2 W	01121	EB 9115
R32, R33	0683-1025		R: fxd comp 1000 Ω $\pm 5\%$ 1/4 W	01121	CB 1025
R34	0683-5115		R: fxd comp 510 Ω $\pm 5\%$ 1/4 W	01121	CB 5115

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A8 (Cont'd)					
R35	0686-3315	4	R: fxd comp 330Ω ±5% 1/2 W	01121	EB 3315
R36, R37	0683-1025		R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R38	0683-1025		R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R39	0686-3315		R: fxd comp 330Ω ±5% 1/2 W	01121	EB 3315
R40	0683-1025		R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R41	0683-5105	2	R: fxd comp 51Ω ±5% 1/4 W	01121	CB 5105
R42	0683-6825		R: fxd comp 6800Ω ±5% 1/4 W	01121	CB 6825
R43	0683-3025	1	R: fxd comp 3000Ω ±5% 1/4 W	01121	CB 3025
R44	0698-5418	2	R: fxd met flm 50Ω ±1% 1/8 W	91637	MFF 1/8 T-O
R45	0757-0402	1	R: fxd met flm 110Ω ±1% 1/8 W	24546	C4-1/8-TO-549R-F
R46	0698-6054	1	R: fxd met flm 73.124Ω ±1% 1/8 W	91637	MFF 1/8 T-2
R47, R48	0757-0413	4	R: fxd met flm 392Ω ±1% 1/8 W	75042	CEA T-O obd
R49*	0757-0411	1	R: fxd met flm 332Ω ±1% 1/8 W	19701	MF5C T-O obd
R50	0757-0417	2	R: fxd met flm 562Ω ±1% 1/8 W	75042	CEA T-O obd
R51	0757-0410	2	R: fxd met flm 681Ω ±1% 1/8 W	75042	CEA T-O obd
R52, R53	0757-0418	4	R: fxd met flm 619Ω ±1% 1/8 W	75042	CEA T-O obd
R54	0757-0416	4	R: fxd met flm 511Ω ±1% 1/8 W	75042	CEA T-O obd
R55	0757-0420	1	R: fxd met flm 750Ω ±1% 1/8 W	19701	MF5C T-O obd
R56	0757-0416		R: fxd prec met flm 511Ω ±1% 1/8 W	75042	CEA T-O obd
R57	0698-0084	2	R: fxd met flm 2150Ω ±1% 1/8 W	75042	CEA T-O obd
R58	2100-2216	2	R: var lin 5000Ω ±30% 1/2 W	73138	62PR obd
R59*	0757-0280		R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
A9					
SINGLE SIDEBAND GENERATOR ASSEMBLY.					
	00313-66509	1	PC Board Assembly	-hp-	
C1	0140-0197	1	C: fxd mica 180 pF ±5%	04062	RDM15F181J3C
C2, C3	0121-0037	2	C: var cer 5-25 pF on schematic	72982	538-002B2PO-03R
CR1 thru CR4	1901-0347	4	Diode: Si 20 mA at +1 1.5 pF	73293	5082-5350
L1	9100-1366		Coil: Inductor var 5-1/2 turns	-hp-	
R1, R2	0757-0407	2	R: fxd met flm 200Ω ±1% 1/8 W /	75042	CEA T-O obd
R3 thru R6	0698-4456	4	R: fxd met flm 549Ω ±1% 1/8 W /	24546	C4-1/8-TO-549R-F
R7, R8	2100-1984	2	R: trimr 100Ω ±10% 1/2 W	30983	ET50W101
R9	0757-0410	2	R: fxd met flm 301Ω ±1% 1/8 W	75042	CEA T-O obd
R10	2100-1984	1	R: var flm 100Ω ±30% 1/2 W	73138	62PR100
R11	0757-0410		R: fxd met flm 301Ω ±1% 1/8 W	75042	CEA T-O obd
R12, R13	0757-0280		R: fxd met flm 1000Ω ±1%	75042	CEA T-O obd
T1, T2	9100-1361	2	Transformer: Trifilar core	-hp-	
T3, T4	9100-1362	2	Transformer: Bifilar	-hp-	
A10					
BUFFER AMPLIFIER ASSEMBLY.					
	00313-66510	1	PC Board Assembly	-hp-	
C1	0160-2035		C: fxd mica 750 pF ±5% 300 V	04062	RDM15F751J3S
C2	0150-0093	4	C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C3	0140-0217	2	C: fxd mica 140 pF ±2%	00853	RDM15F141G3C
C4	0140-0178	1	C: fxd mica 560 pF ±2%	04062	RDM15F561G3C
C5 thru C7	0150-0093		C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C8	0140-0217		C: fxd mica 140 pF ±2%	04062	RDM15F141G3C
C9	0140-0200		C: fxd mica 390 pF ±5%	04062	RDM15F391J3C

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
L1, L2	0100-1366		2	Coil: Inductor var 5-1/2 turns	-hp-	
Q1	1854-0210			TSTR: Si NPN 2N3663	24446	obd
Q2	1854-0053			TSTR: Si NPN 2N2218	04713	obd
R1	0757-0277		1	R: fxd met flm 49.9Ω ±1% 1/8 W	10701	MF5C T-O obd
R2, R3	0683-2035		4	R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R4	0683-3325		1	R: fxd comp 3300Ω ±5% 1/4 W	01121	CB 3325
R5, R6	0683-2035			R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R7	0683-6215		1	R: fxd comp 620Ω ±5% 1/4 W	01121	CB 6215
A11				BROADBAND AMPLIFIER ASSEMBLY		
	00313-66511		1	PC Board Assembly	-hp-	
C1 thru C5	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C6	0140-0176		2	C: fxd mica 100 pF ±2%	04062	RDM15F101G3C
C7	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C8	0140-0176			C: fxd mica 100 pF ±2%	04062	RDM15F101G3C
C9, C10	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
K1, K2	0490-0399			Relay: Reed assembly 1200Ω	-hp-	
L1	9140-0106		1	Coil: fxd 0.47 μH ±20% 1340 mA	76493	9310-06
Q1 thru Q3	1854-0219			TSTR: Si NPN 2N3663	24446	obd
R1, R2	0757-0413			R: fxd met flm 392Ω ±1% 1/8 W	75042	CEA T-O obd
R3	0757-0277			R: fxd met flm 49.9Ω ±1% 1/8 W	19701	MF5C T-O obd
R4	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R5	0683-2035			R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R6	0683-2025			R: fxd comp 2000Ω ±5% 1/4 W	01121	CB 2025
R7	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R8	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R9	0683-2035			R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R10	0683-1325			R: fxd comp 1300Ω ±5% 1/4 W	01121	CB 1325
R11	0683-1015			R: fxd comp 100Ω ±5% 1/4 W	01121	CB 1015
R12	0683-1335		1	R: fxd comp 13 kΩ ±5% 1/4 W	01121	CB 1335
R13	0683-2425			R: fxd comp 2400Ω ±5% 1/4 W	01121	CB 2425
R14	0683-5615			R: fxd comp 560Ω ±5% 1/4 W	01121	CB 5615
R15	0683-5105			R: fxd comp 51Ω ±5% 1/4 W	01121	CB 5105
A12				LOCAL OSCILLATOR ASSEMBLY.		
	00313-66512		1	PC Board Assembly	-hp-	
	0340-0059		1	Terminal: standoff	00866	1332 obd
C1*	0160-0356			C: fxd mica 18 pF ±5%	-hp-	
C2	0121-0128		1	C: var air 1.4 - 7.3 pF	74950	189-505-5
C3 thru C8	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
CR1, CR2	1910-0022			Diode: Ge 5 wiv 3.5 ns	93332	obd
Q1, Q2	1855-0081		2	TSTR: Si FET 2N5245	01295	2N5245
R1	0757-0461		1	R: fxd met flm 68.1 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R2	0757-0468		1	R: fxd met flm 130 kΩ ±1% 1/4 W	19701	MF5C T-O obd
R3	0757-0273		2	R: fxd met flm 3010Ω ±1% 1/8 W	19701	MF5C T-O obd
R4	0757-0410		1	R: fxd met flm 301Ω ±1% 1/8 W	75042	CEA T-O obd
R5	0757-0474		1	R: fxd met flm 243 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R6	0757-0481		1	R: fxd met flm 475 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R7	0757-0273			R: fxd met flm 3010Ω ±1% 1/8 W	19701	MF5C T-O obd
R8	0757-0280			R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO
A13			10dB STEP ATTENUATOR ASSEMBLY.		
	00313-63401	1	Attenuator Assembly	-hp-	
J1	1250-0083		Connector: RF series BNC bulkhead mount jack	95712	30624-1 obd
R1, R2	0727-0091		R: fxd carbon flm $790\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R3	0727-0028	4	R: fxd carbon flm $53.3\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R4	0727-0016	1	R: fxd carbon flm $26.3\Omega \pm 1/2\%$ 1/2 W	19701	MF6C obd
R5	0727-0028		R: fxd carbon flm $53.3\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R6	0727-0037	1	R: fxd carbon flm $71.16\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R7, R8	0727-0042	2	R: fxd carbon flm $96.25\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R9	0727-0062	1	R: fxd carbon flm $247.5\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R10, R11	0727-0034	2	R: fxd carbon flm $61.11\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R12	0727-0091		R: fxd carbon flm $790\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R13, R14	0727-0028		R: fxd carbon flm $53.3\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
S1 thru S8	3101-0933	16	Switch: sensitive subminiature	000LG	23SM13
	355C-107D	1	Actuator switch: long	-hp-	
	355C-107E	3	Actuator switch: short	-hp-	
	355C-108A	1	Cam "A" attenuator	-hp-	
	355C-108B	1	Cam "B" attenuator	-hp-	
	355C-108C	1	Cam "C" attenuator	-hp-	
	355C-108D	1	Cam "D" attenuator	-hp-	
	355C-108E	1	Cam "E" attenuator	-hp-	
	739A-41A	1	Cover: accessory top	-hp-	
	739A-101	1	Pin: detent	-hp-	
	739A-102	1	Roller: assembly	-hp-	
	00313-23702	1	Shaft: straight	-hp-	
	739A-91	1	Spring: assembly	-hp-	
	00313-22001	1	Body	-hp-	
	0360-0124	1	Terminal: pin for printed circuit board	97300	obd
	00313-21701	1	Bushing	-hp-	
	00313-69701		Shaft and Cam Assembly	-hp-	
A14			1dB STEP ATTENUATOR ASSEMBLY.		
CI* thru C4*	00313-63402	1	Attenuator Assembly	-hp-	
	0150-0022		C: fxd 3.3 pF 500 vdcw	95121	Type QC
J1	1250-0083	2	Connector: RF series BNC jack	95712	30624-1
R1, R2	0727-0010	3	R: fxd carbon flm $17.61\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R3	0727-0064	4	R: fxd carbon flm $292.4\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R4	0727-0379		R: fxd carbon flm $146.2\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R5	0727-0064		R: fxd carbon flm $292.4\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R6	0727-0005	1	R: fxd carbon flm $5.77\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R7, R8	0727-0094	2	R: fxd carbon flm $870\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R9	0727-0008	1	R: fxd carbon flm $11.61\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R10, R11	0727-0074		R: fxd carbon flm $463\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R12	0727-0010		R: fxd carbon flm $17.61\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R13, R14	0727-0064		R: fxd carbon flm $292.4\Omega \pm 1/2\%$ 1/4 W	19701	MF6C obd
R15	0757-1025	1	R: fxd met flm $25\Omega \pm 1\%$ 1/4 W	19701	MF6C T-O obd
S1 thru S8	3101-0933	8	Switch: sensitive subminiature SPDT	000LG	23SM13 obd
	355C-107D	1	Actuator: switch long	-hp-	
	355C-107E	3	Actuator: switch short	-hp-	
	00313-22002	1	Body: attenuator	-hp-	
	00313-21701	1	Bushing: front	-hp-	
	00313-61604	1	Cable assembly: output Opt. 01	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A14 (Cont'd)					
	355C-108A	1	Cam "A" attenuator	-hp-	
	355C-108B	1	Cam "B" attenuator	-hp-	
	355C-108C	1	Cam "C" attenuator	-hp-	
	355C-108D	1	Cam "D" attenuator	-hp-	
	355C-108E	1	Cam "E" attenuator	-hp-	
	739A-41A		Cover: access, top	-hp-	
	739A-101	1	Pin: detent	-hp-	
	739A-102	1	Roller: assembly	-hp-	
	00313-23702	1	Shaft: straight	-hp-	
	739A-91	1	Spring assembly	-hp-	
	1209-0063	1	Receptacle: crimp type pin	00779	42428-3
	1250-0083	1	Connector RF: series BNC jack	95712	30624-1
	00313-69701		Shaft and Cam Assembly	-hp-	
A15			0.1dB STEP ATTENUATOR ASSEMBLY.		
	00313-61901	1	Attenuator Assembly	-hp-	
R1, R2	0698-4966	2	R: fxd met flm 340 k Ω \pm 1% 1/2 W	75042	CEC T-O obd
R3, R4	0757-0307	2	R: fxd met flm 322 k Ω \pm 1% 1/2 W	75042	CEC T-O obd
R5, R6	0698-4965	2	R: fxd met flm 324 k Ω \pm 1% 1/2 W	75042	CEC T-O obd
R7, R8	0698-3425	2	R: fxd met flm 316 k Ω \pm 1% 1/2 W	75042	CEC T-O obd
R9	0757-0312	1	R: fxd met flm 309 k Ω \pm 1% 1/2 W	19701	MF7C T-O obd
S1	3106-1746	1	Switch: rotary	71590	1332 obd
	00313-69701		Shaft and Cam Assembly	-hp-	
A16			POWER AMPLIFIER AND DETECTOR ASSEMBLY. (OPTION 01)		
	00313-66513	1	PC Board Assembly This board is identical to the A8 board except for:		
R49	0757-0282	1	R: fxd met flm 221 Ω \pm 1% 1/8 W	75042	CEA T-O obd
A17			1dB STEP ATTENUATOR ASSEMBLY. (OPTION 01)		
	00313-63403	1	Attenuator Assembly (Option 01) This attenuator is identical to the A14 attenuator except as follows: A14R15 replaced by a shorting strip A14J1 deleted (output cable W3 attaches directly to A17 Attenuator Assembly)	-hp-	
			MECHANICAL PARTS.		
A1	00313-66501	1	Board: power supply	-hp-	
A2	00313-66502	1	Board: oscillator	-hp-	
A3	00313-66503	1	Board: amplifier	-hp-	
A4	00313-66504	1	Board: XTAL oscillator	-hp-	
A5	00313-66505	1	Board: AGC amplifier	-hp-	
A6	00313-66506	1	Board: output mixer	-hp-	
A7	00313-66507	1	Board: L. P. filter	-hp-	
A8	00313-66508	1	Board: RF amplifier and detector (standard only)	-hp-	
A9	00313-66509	1	Board: SSB generator	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
MECHANICAL PARTS (Cont'd)					
A10	00313-66510	1	Board: 30 MHz buffer	-hp-	
A11	00313-66511	1	Board: bandpass amplifier	-hp-	
A12	00313-66512	1	Board: local oscillator	-hp-	
A13	00313-63401	1	Attenuator assembly: 10 dB step	-hp-	
A14	00313-63402	1	Attenuator assembly: 1 dB step	-hp-	
A15	00313-61901	1	Switch: attenuator assembly	-hp-	
A16 (A8 Opt. 01)	00313-66513	1	Board: RF amplifier and detector (Opt. 01 only) This board is identical to 00313-66508 board except for value of A16R49 A16R49 is 221Ω	-hp-	
A17	00313-63403	1	Switch: attenuator assembly 1 dB step (Opt. 01 only)	-hp-	
C1, C2	0180-0047	2	C: fxd 500 μF 75 vdcw	56289	D32443
C3, C4	0150-0023	2	C: fxd cer 2000 pF ±20% 1000 vdcw	56289	19C203A
C5	0121-0194	1	C: var air 4.8 to 100 pF	74970	148-6-HB
C6 thru C9	0150-0093	4	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C10 thru C21	0150-0019	12	C: fxd 0.001 feedthru cer 1000 pF ± 20%	72982	327005X5U0 102M
F1	2110-0044 2110-0320	1	Fuse: 0.30 A slow-blow (115 V) Fuse: 0.15 A slow-blow (250V)	75915 75915	313.300 313.150S
J1	1251-2357	1	Connector: AC power HP-9 male flg mtg	-hp-	
J3, J4	1250-0118	2	Connector: RF series BNC bulkhead mount jack receptacle	74868	82-2908-2
J5, J6	1250-0083	2	Connector: RF bulkhead mount jack	95712	30624-1 obd
J7	00313-61603		Part of cable W3	-hp-	
J8 thru J10	1251-0160	3	Connector: printed circuit	71785	250-15-30-21C
L1	9100-1368	1	Coil: var (uses form 9150-0376)	-hp-	
L2, L3	9140-0018	2	Coil: RF choke 1 μH	99849	205-11-10
M1	1120-0930	1	Meter	55026	1332 obd
MP1	5000-0737	2	Cover: side front	-hp-	
MP2	5000-0736	2	Cover: side rear	-hp-	
MP3	5060-0740	1	Cover: top	-hp-	
MP4	00313-00208	1	Panel: rear	-hp-	
MP5	5000-0051	2	Plate: fluted aluminum	-hp-	
MP6	00313-24401	2	Frame: assembly	-hp-	
MP7	5060-0766	2	Retainer: 4H handle	-hp-	
MP8	5060-0763	2	Handle: assembly	-hp-	
MP9	5060-0752	1	Cover: bottom	-hp-	
MP10	5060-0767	5	Foot: assembly	-hp-	
MP11	1490-0030	1	Stand: tilt	91260	obd
MP12	00313-00201	1	Panel: front	-hp-	
MP12	00313-00203	1	Panel: front	-hp-	
Opt. 01					
MP13	5000-5835	2	Strip: trim	-hp-	
MP14	00313-04301	1	Panel: plate	-hp-	
MP15	5000-5836	1	Strip: top front panel	-hp-	
MP16			Not assigned		
MP17	00313-24702	1	Support: tuner drive bearing	-hp-	
MP18	5060-0021	1	Gear Assembly	-hp-	
MP19	5060-0020	1	Gear Assembly	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
MECHANICAL PARTS (Cont'd)					
MP20	00313-23601	1	Gear: drive assembly	-hp-	
MP21	00313-24701	1	Spacer: (Stand off)	-hp-	
MP22	1500-0783	1	Drive Mechanism	000LC	145"/DAF SPEC
MP23			Not assigned		
MP24	00313-04001	1	Dial: frequency	-hp-	
MP25	1410-0103	1	Bushing: oscillator tuning	13603	FAD 250
MP26	00313-49901	1	Inductor: frequency dial (bezel)	-hp-	
MP27	0370-0146	1	Knob: oscillator tuning assembly	-hp-	
MP28	0370-0128	1	Knob: 3/4" scale offset round black	-hp-	
MP29	0370-0114	1	Knob: round 5/8" diam red (scale offset)	-hp-	
MP30	0370-0432	3	Knob: lever black	-hp-	
MP31	4040-0297	1	Meter: window bezel	-hp-	
MP32	1410-0112	1	Bushing: brass	14480	obd
MP33	0370-0330	3	Knob: 4 fluted 5/8" bar type (black)	-hp-	
MP34	5040-0687	1	Bezel: rear window	-hp-	
MP35	5040-0686	2	Bezel: front window	-hp-	
MP36	5020-0446	1	Standoff: hex	-hp-	
MP37	1460-0256	4	Spring: meter compression	91260	obd
MP38	1410-0872	1	Bushing: threaded	14480	obd
MP39	5040-0690	3	Dial: attenuator molded	-hp-	
	7120-0870	3	Decal	91345	1332 obd
MP40	00313-04901	1	Gusset: front	-hp-	
MP41	5020-0350	2	Shaft: 5-1/8"	-hp-	
MP42	1500-0001	2	Coupler: flexible	80583	FNC-46-S
MP43			Not assigned		
MP44	5000-1052	1	Casting: RF	-hp-	
MP45	00313-04902	1	Gusset: center	-hp-	
MP46	00313-04103	2	Cover: attenuator bottom	-hp-	
MP47	2110-0359	1	Holder: fuse extractor post type 250 V	75915	342012
MP48	0340-0580	2	Insulator: XSTR to -3.011-thk	-hp-	
MP49	1200-0081	4	Insulator: bushing	26365	974 Special
MP51	5040-1464	6	Extractor: board	-hp-	
MP52	00313-01201	2	Bracket: circuit guide	-hp-	
MP53	739A-41A	2	Cover: attenuator top	-hp-	
MP54	00313-04101	1	Cover: top casting	-hp-	
MP55	00313-04102	1	Cover: bottom casting	-hp-	
MP56	5040-0601	6	Guide: printed circuit	-hp-	
MP57	00313-00102	1	Deck	-hp-	
MP58	1410-0872	1	Bushing: PNL	-hp-	
MP59	7120-1254	1	Nameplate	000LH	obd
MP60	1500-0001	2	Coupler: flexible for 1/4" diameter shafts	80583	FNC-46-S
MP61	00313-01202	1	Bracket: attenuator mounting	-hp-	
MP62	1410-0094	1	Bushing: PNL	-hp-	
Q1, Q2	1854-0063	2	TSTR: Si NPN 2N3055	04713	2N3055
R1, R2	0692-1005	2	R: fxd comp 10 Ω \pm 5% 2 W	01121	HB 1005
R3	0684-3331	1	R: fxd comp 33 k Ω \pm 10% 1/4 W	01121	CB 3331
R4	0698-4482	1	R: fxd met flm 17.4 k Ω \pm 1% 1/8 W	75042	CEA T-O obd
R5	0698-0083	1	R: fxd met flm 1960 Ω \pm 1% 1/8 W	75042	CEA T-O obd
R6	2100-0078	1	R: var comp lin 500 Ω \pm 30% 3/10 W	71450	Series 70 obd
R7	2100-1736	1	R: var dual 100-10%-CC 3k-10%-CC	-hp-	
S1	3101-1248	1	Switch: 10.5A 250 V AC	00501	53-55480-121/A1H

Table 6-1, Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
MECHANICAL PARTS (Cont'd)					
S2	3101-1234	1	Switch: 1.5A 250 V AC	82389	11A-1242A
S3	3101-0820	1	Switch: lever oscillator mode	71590	1332 obd
S4	3101-0819	1	Switch: meter mode	71590	1332 obd
S5	3101-0820	1	Switch: lever oscillator mode	71590	1332 obd
T1	9100-1345	1	Transformer: power	-hp-	
	00313-00601		Shield-transformer bottom	-hp-	
W1	9120-1348		Assembly: cable 3-cond 18 awg	-hp-	
W2	00313-61602	1	Cable: output casting assembly	-hp-	
W3	00313-61603	1	Cable: output connector assembly standard only	-hp-	
W3 (Opt. 01)	00313-61604		Cable assembly: output (Opt. 01 only)	-hp-	
W4	00313-61601	1	Cable: main	-hp-	
MISCELLANEOUS					
	11086A	3	Accessory: (cables) coaxial 24"	-hp-	
	1250-0701	2	Bushing: RF connector for series BNC TNC connectors	95712	9520-3 obd
	9211-0249	1	Carton: corrugated	09051	obd
	5060-4940	1	Extender assembly: 15 pin	-hp-	
	9223-0040	4	Foam: polyethylene post pak	04811	obd
	1250-0299	2	Insulator: RF connector back-insulator for series BNC/TNC connectors	95712	2624-1
	5060-0775	1	Kit: 5 H rack mount	-hp-	
	5020-0708	1	bracket	-hp-	
	502C-0709	1	bracket	-hp-	
	11086-61601	3	cable	-hp-	
	5060-4940	1	extender board	-hp-	
	5040-0164	1	filler strip	-hp-	
	5950-4401	1	label	-hp-	
	2550-0018	4	machine screw	-hp-	
	9220-0195	1	polyboard	-hp-	
	8120-0078	1	power cord	-hp-	
	00313-90001	1	Manual	-hp-	
	2950-0054	1	Nut: hex brass nickel plated	95712	obd
		2	Nut: RF connector clamp for series BNC/TNC connectors	95712	834-33 obd
	7122-0082	1	Plate: serial	04716	obd
	00313-23701	1	Shaft: 1-5/8" (5020-0341)	-hp-	
	0362-0027	2	Sleeve: cable terminal bronze	59730	GSC-2195
		2	Washer: flat for series BNC RF connectors	95712	2053-8
	2370-0013	8	Screws, top and bottom attaching	73076	obd
	2370-0020	8	Screws, side cover attaching	83385	obd

SCHEMATIC DIAGRAMS

SECTION VII CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the manual contains circuit diagrams for the Model 313A. Included is a block diagram, a functional diagram, an interconnecting block diagram between the Model 313A and the Model 312A and schematic diagrams.

7-3. BLOCK DIAGRAM.

7-4. The block diagram (Figure 7-1) shows how the circuits in the Model 313A are functionally arranged to form a Tracking Oscillator.

7-5. FUNCTIONAL DIAGRAM.

7-6. The functional diagram (Figure 7-3) is similar to the block diagram except more detailed information is included. Included in the functional diagram are adjustments, waveforms, frequencies, switches and relays as related to the functional operation of the Model 313A.

7-7. Circuits located within the RF casting are shown enclosed by dashed lines. Individual compartments within the casting are also shown enclosed with dashed lines. Feedthru capacitors which supply operating potentials to circuits within the casting are shown. Connections between circuit boards within the casting are made by pin type connectors.

7-8. Numbers enclosed in circles relate to the troubleshooting tree (Figure 5-10) and indicate the sequence in which troubleshooting steps should be performed.

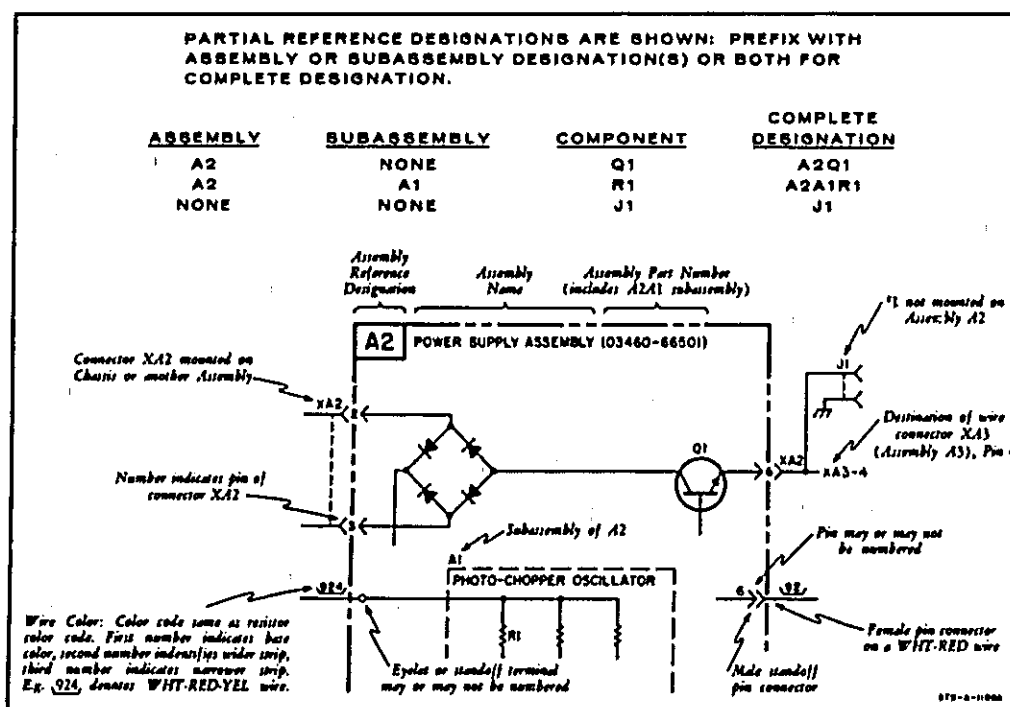
7-9. SCHEMATIC DIAGRAMS.

7-10. The schematic diagrams (Figures 7-4 through 7-9) contained in this section show the detailed circuits in the Model 313A. Individual circuit boards are shown enclosed in dashed lines. Some components which are part of a particular circuit but physically located off the board are shown on the board and are enclosed by a series of short diagonal lines.









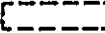



7-11. Components marked with an asterisk are those that are critical in value. The value of these components may vary from one instrument to another due to variations in transistor Beta etc. and the values shown on the schematic are average. Numbers in parenthesis indicate the paragraph number in the manual where the method of selecting the optimum value can be found.

7-12. Voltage levels and some waveforms have been included on the schematics. When measuring these voltages a high input impedance voltmeter (10 megohms or greater) and oscilloscope should be used to prevent circuit loading.

REFERENCE DESIGNATIONS



GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
 RESISTANCE IN OHMS
 CAPACITANCE IN MICROFARADS
 INDUCTANCE IN MICROHENRIES
3.  DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.
4.  DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.
5.  DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).
6.  DENOTES ASSEMBLY.
7.  DENOTES RF CASTING.
8.  DENOTES MAIN SIGNAL PATH.
9.  DENOTES FEEDBACK PATH.
10.  DENOTES FRONT PANEL MARKING.
11.  DENOTES REAR PANEL MARKING.
12.  DENOTES SCREWDRIVER ADJUST.
13.  DENOTES FRONT PANEL CONTROL.
14. 924 DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP.
(e. g. 924 = WHITE, RED, YELLOW.)
15. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
16. (0-00) NUMBERS IN PARENTHESIS INDICATE THE PARAGRAPH NUMBER IN MANUAL WHERE METHOD OF SELECTING STARRED VALUES IS FOUND.
17. TRANSISTORS ARE ALL CONNECTED TO CIRCUIT BOARD IN TO-5 CONFIGURATION, ie,  AS VIEWED FROM THE COMPONENT SIDE OF BOARD.
18. WAVEFORM AND VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING A HIGH INPUT IMPEDANCE OSCILLOSCOPE AND TRANSISTOR VOLTMETER. VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY SOMEWHAT FROM ONE INSTRUMENT TO ANOTHER.

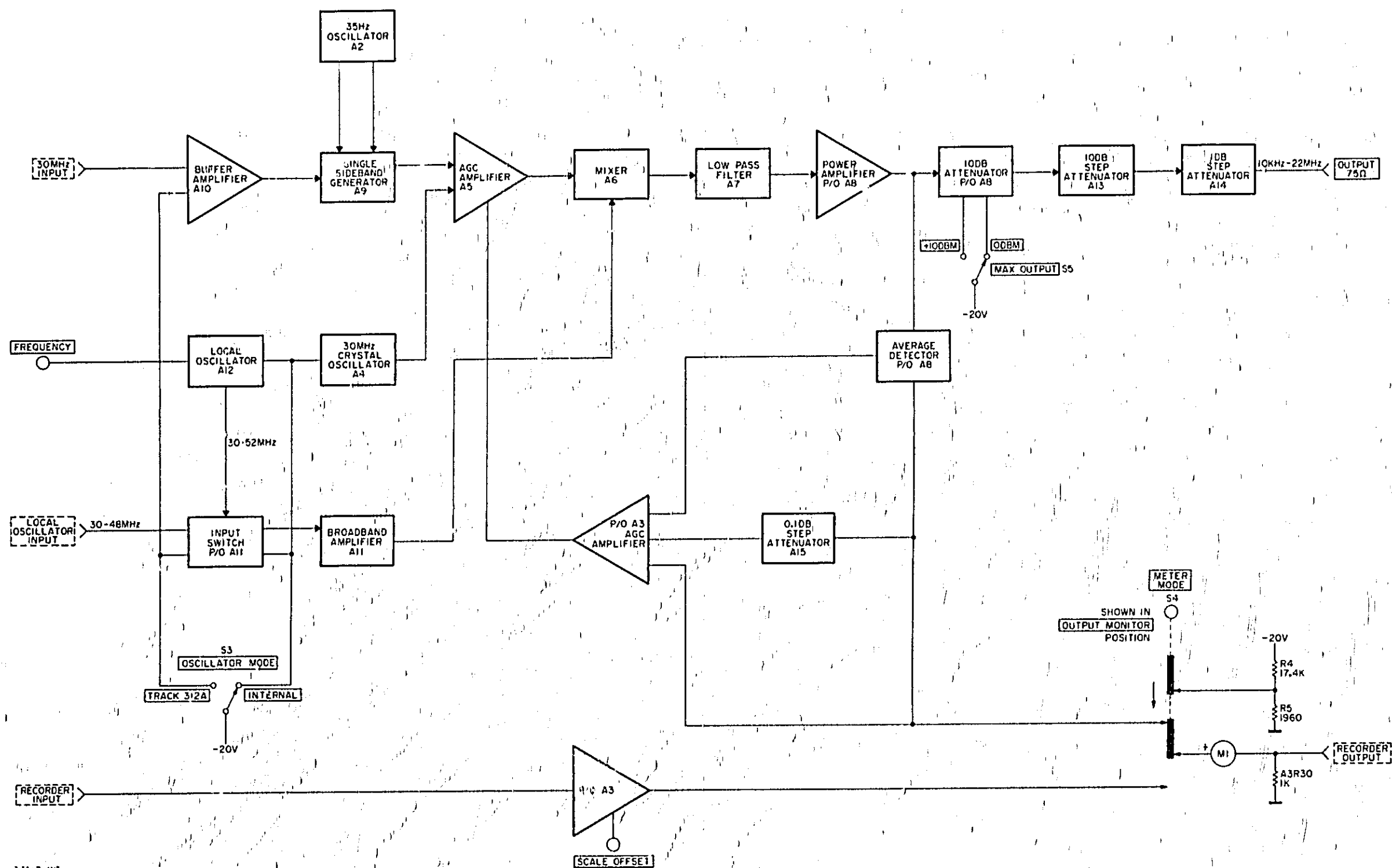
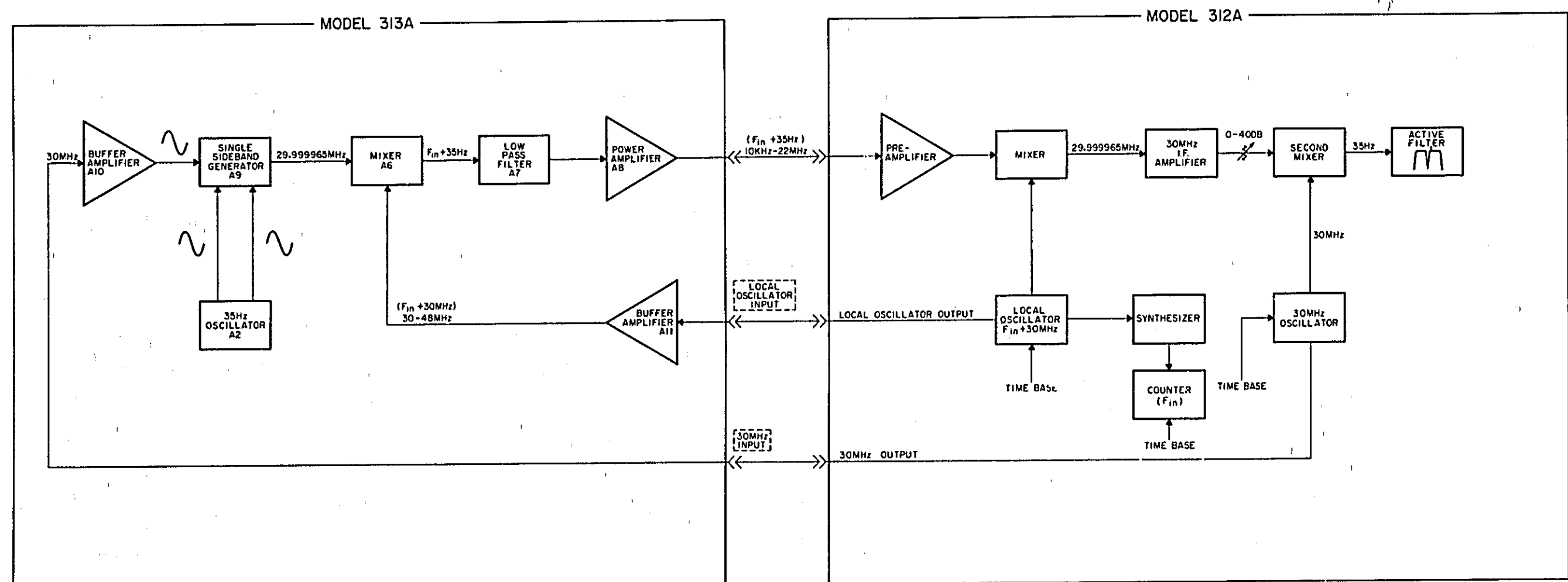


Figure 7-1. 313A Block Diagram.
7-3/7-4.



313A-0-1113

Figure 7-2. 313A-312A Interconnecting Block Diagram.
7-5/7-6.

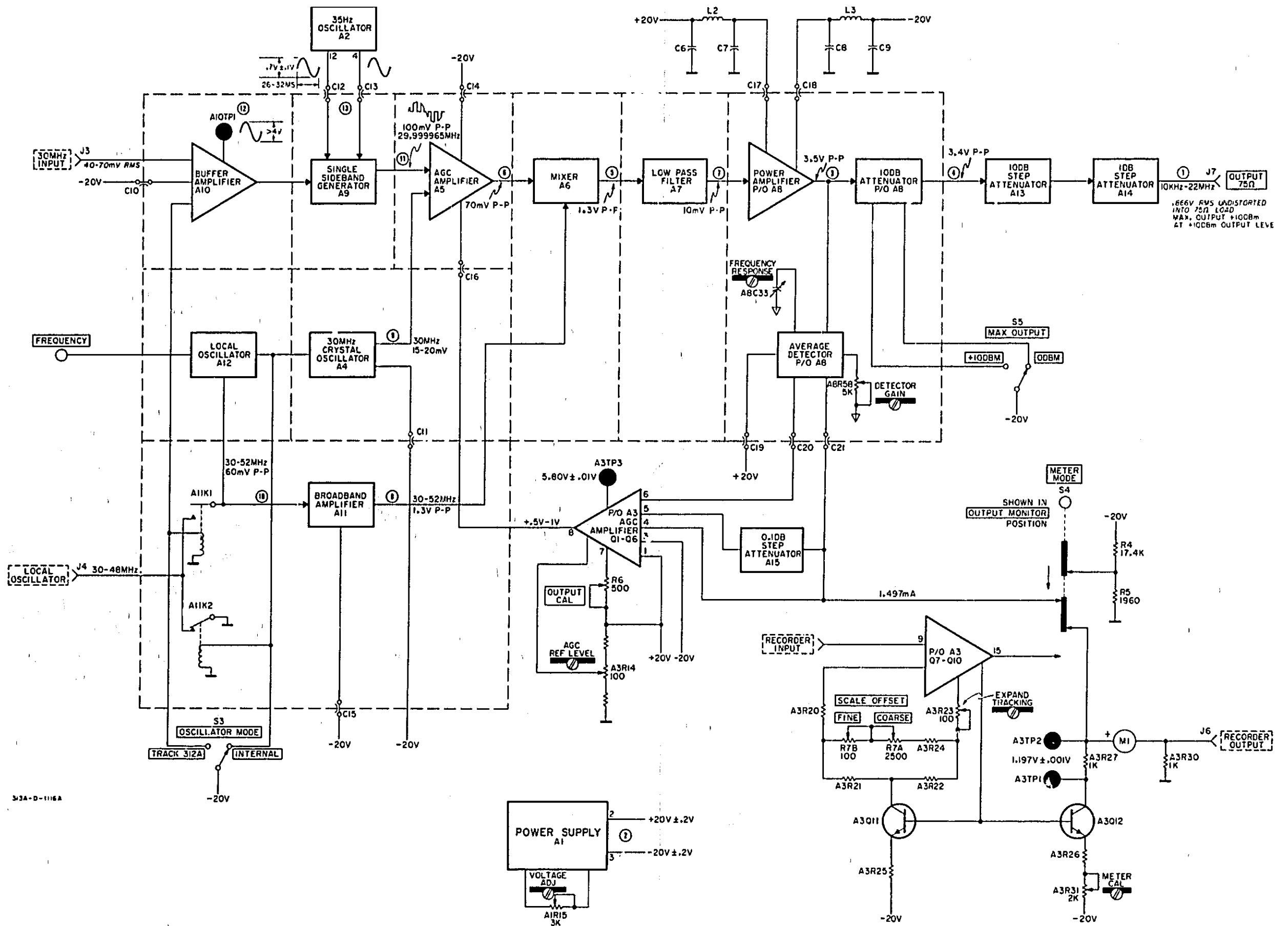
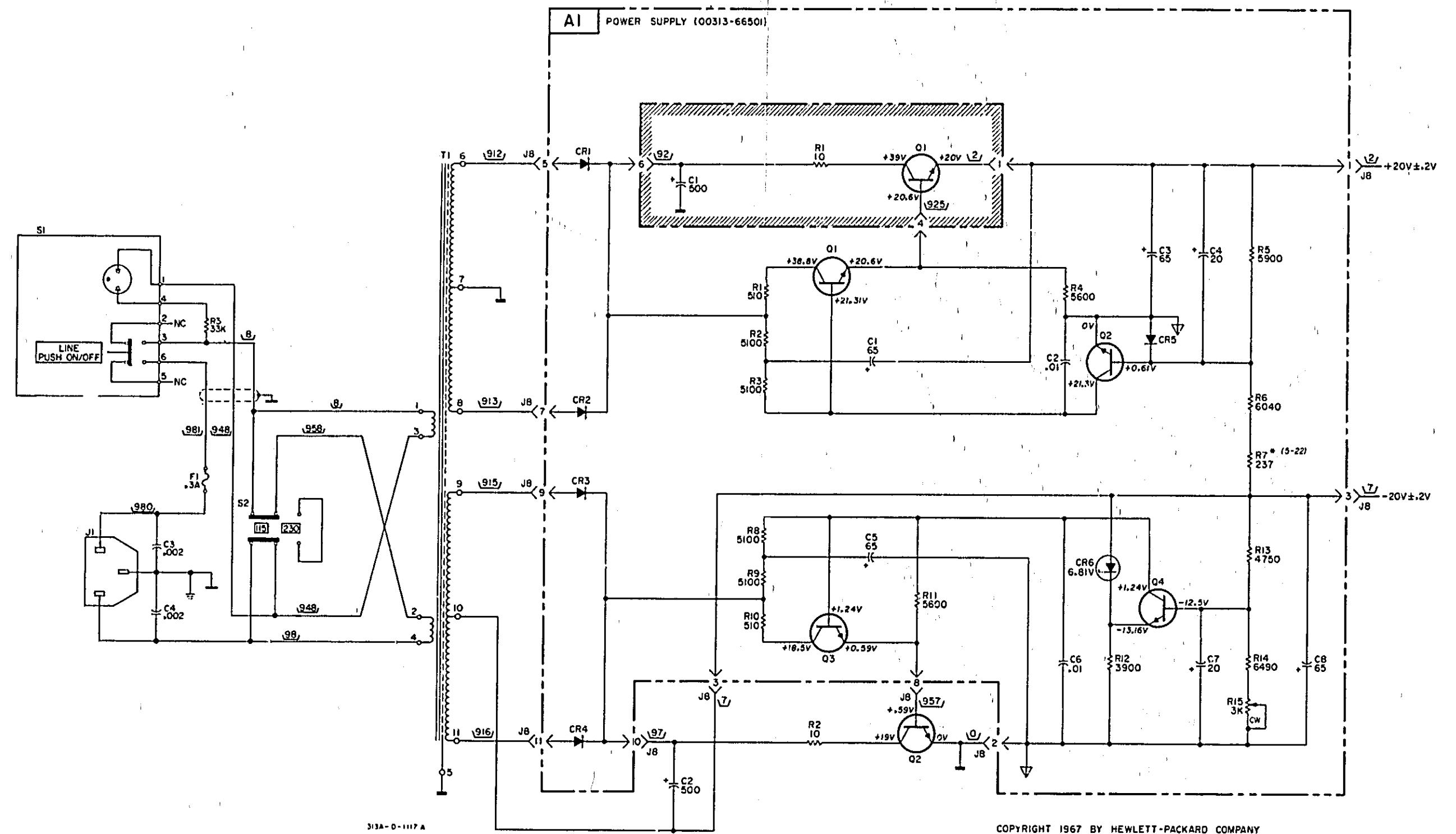


Figure 7-3. 313A Functional Diagram.
7-7/7-8.



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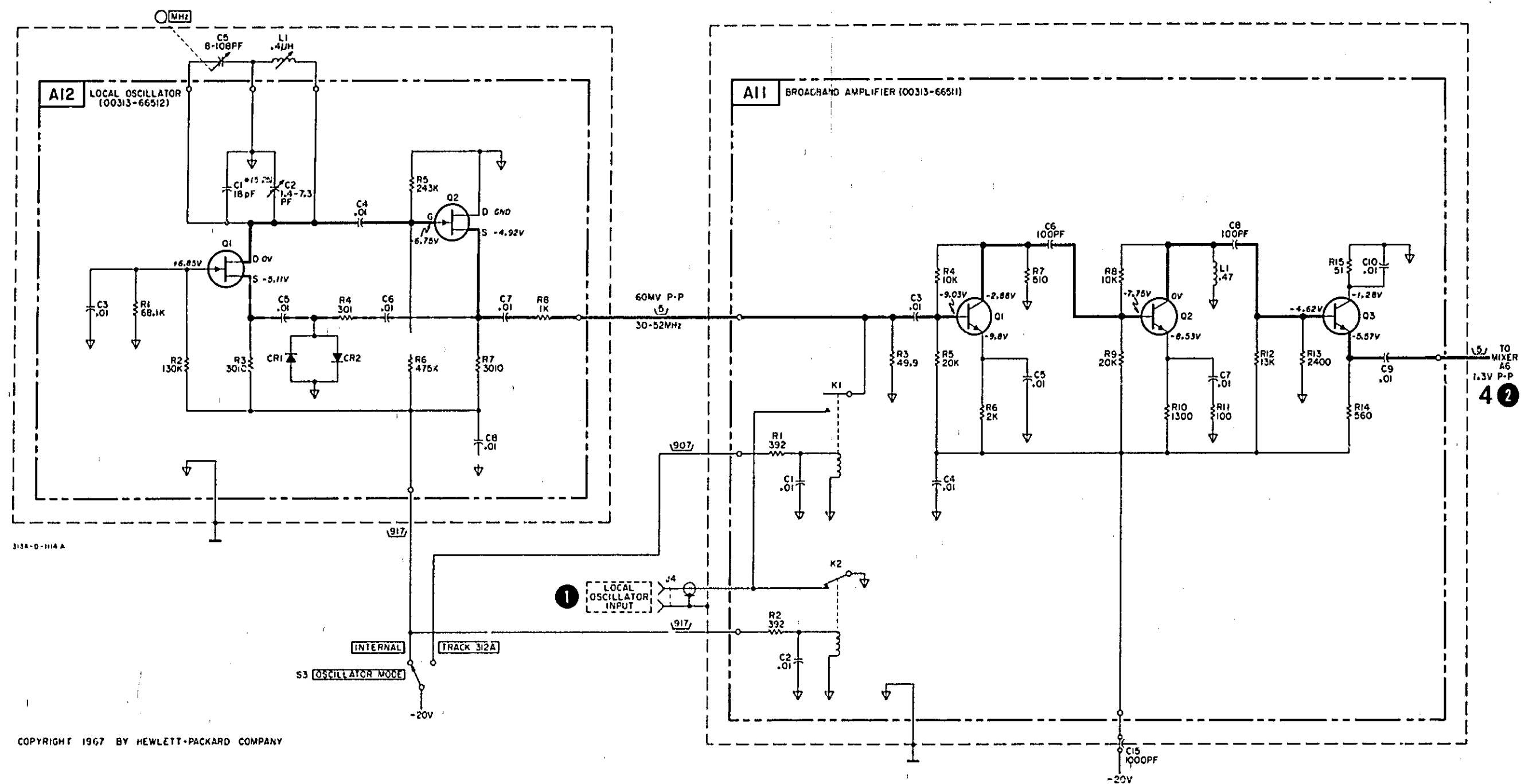
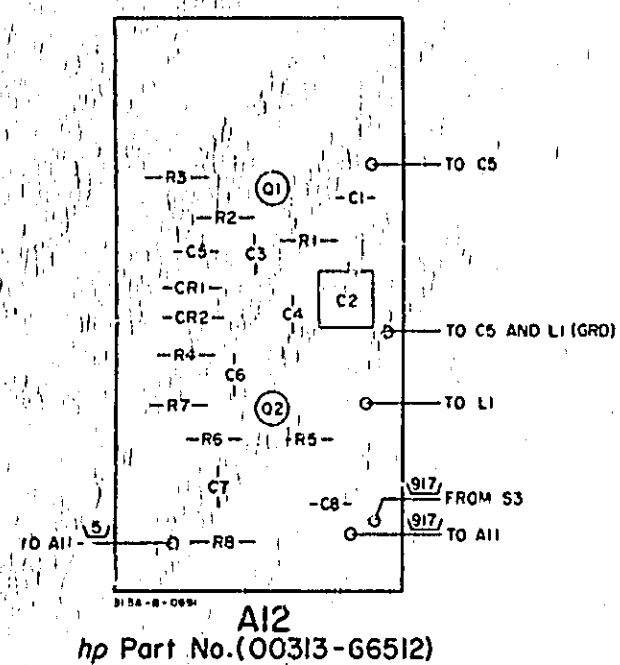
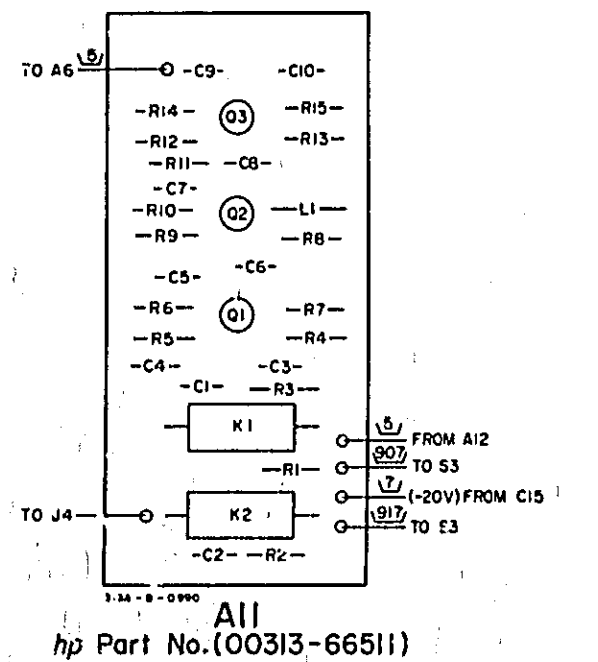


Figure 7-5. Local Oscillator (A12) Buffer Amplifier (A11) Schematic and Component Location Diagrams.
 7-11/7-12.

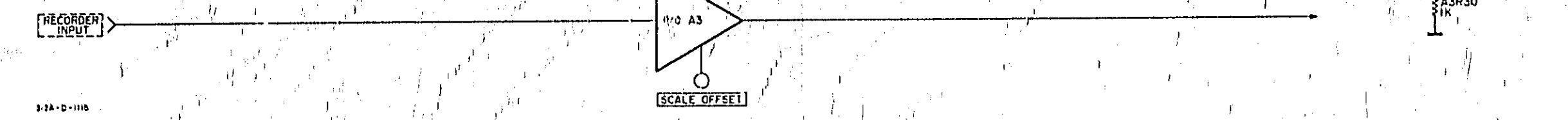


Figure 7-1. 313A Block Diagram.
7-3/7-4.

Figure 7-2. 313A-312A Interconnecting Block Diagram.
7-5/7-6.

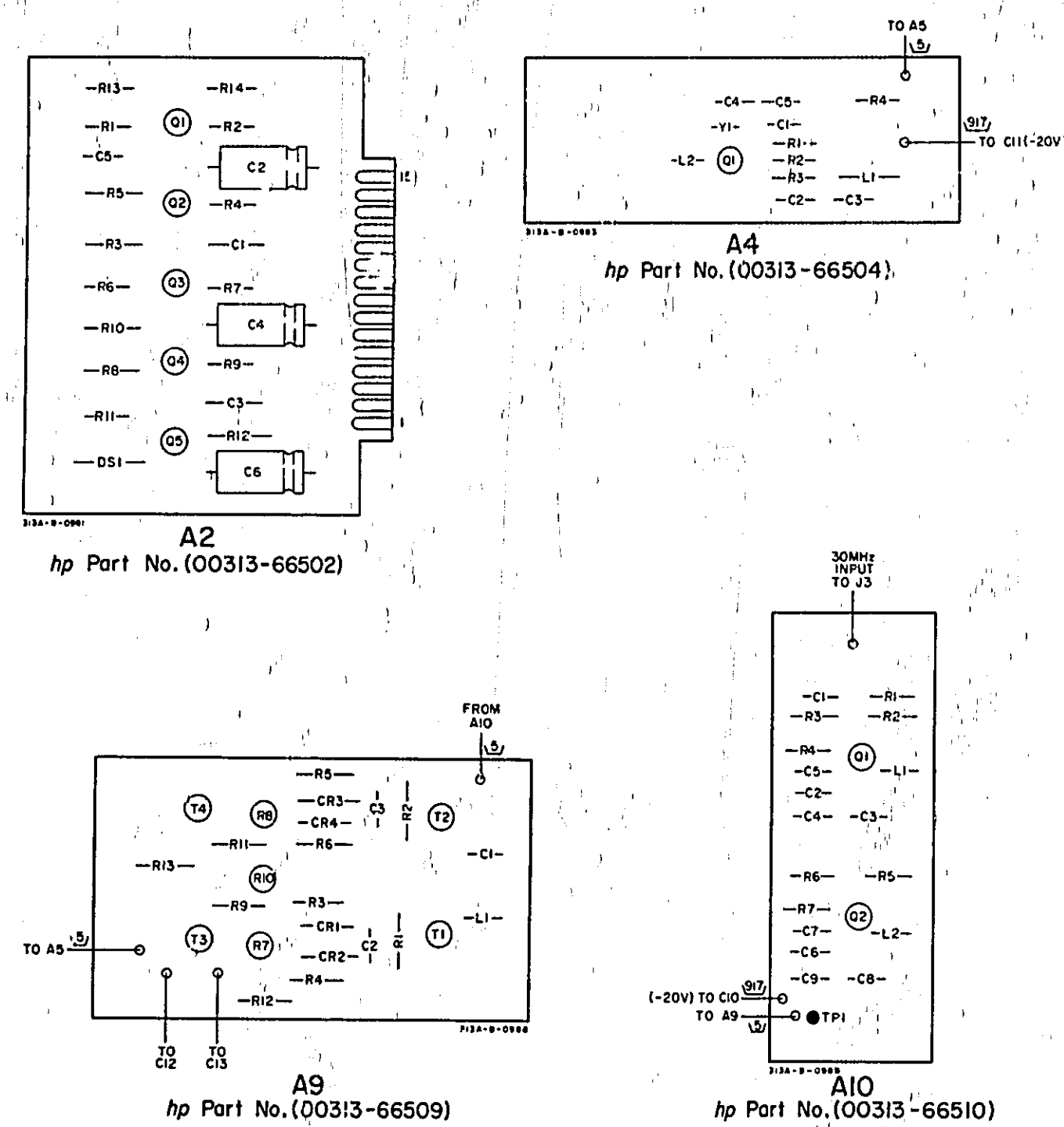
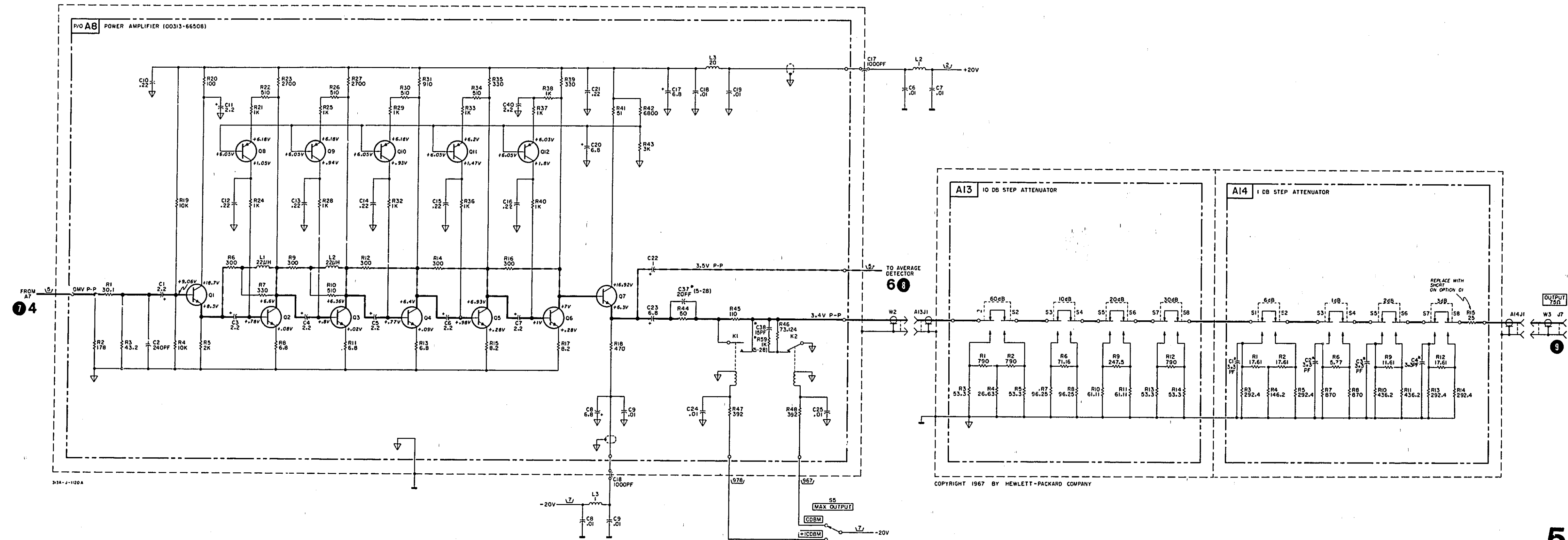
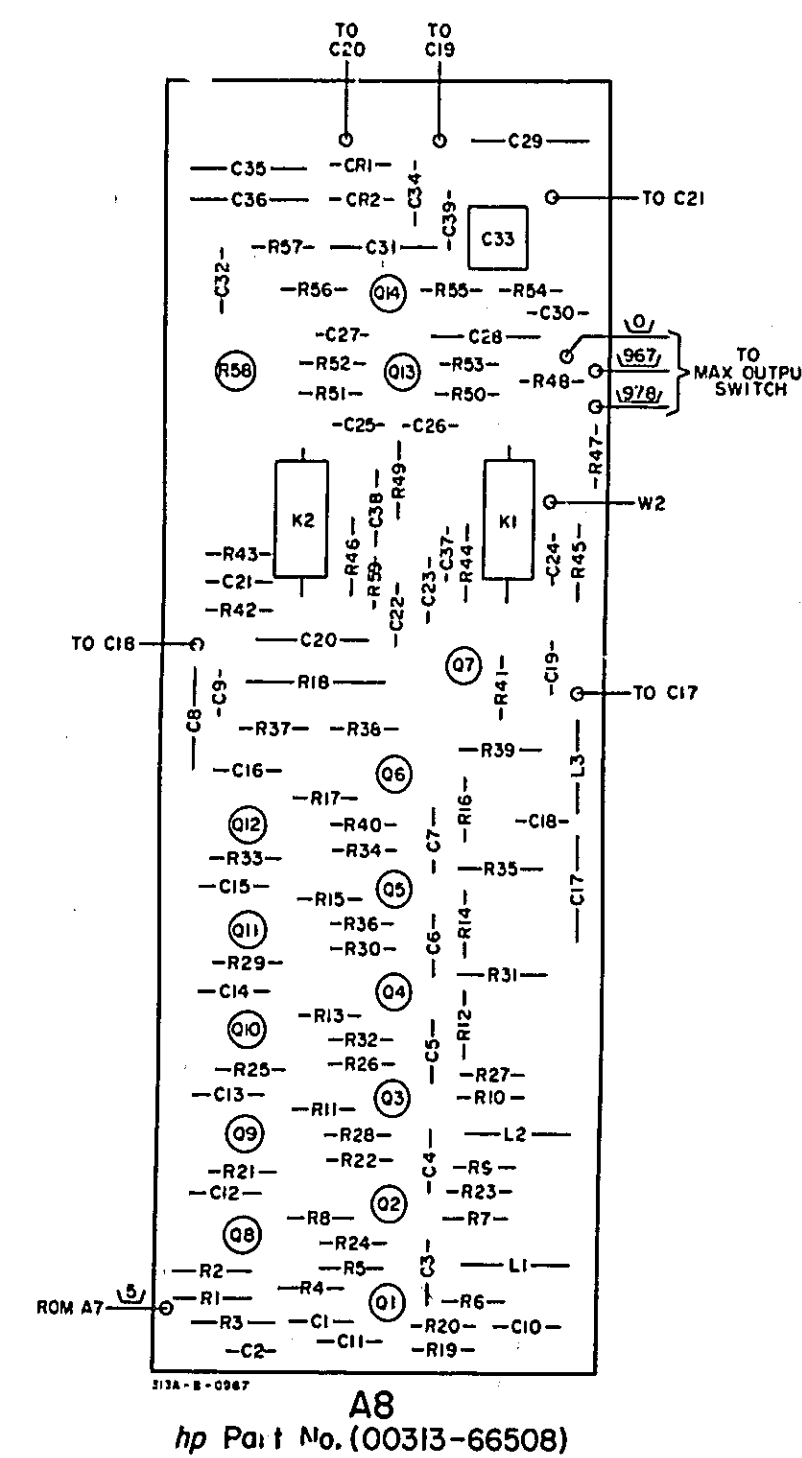


Figure 7-6. Buffer Amplifier (A10), Single Sideband Generator (A9), Delta Oscillator (A2) Crystal Oscillator (A4) Schematic and Component Location Diagram.
7-13/7-14



5

Figure 7-8. Power Amplifier (P/O A8), 10 dB Pad (P/O A8), 10 dB Step Attenuator (A13), 1 dB Step Attenuator (A14) Schematic and Component Location Diagrams.

7-17/7-18

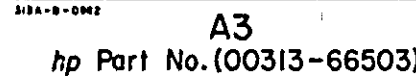


Figure 7-9. Average Detector (P/O A8), AGC Amplifier (P/O A3), Meter Expand Amplifier (P/O A3). 0.1 dB Step Attenuator Schematic and Component Location Diagrams.
7-19/7-20

APPENDIX

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U.S.	05347	Ultronix, Inc.	San Mateo, Cal.	11236	CTE of Berne, Inc.	Berne, Ind.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05307	Union Carbide Corp., Elect.		11737	Chicago Telephone of	
00213	Sage Electronics Corp.	Rochester, N. Y.		Div.	New York, N. Y.		California, Inc.	So. Pasadena, Cal.
00287	Cemco, Inc.	Danielson, Conn.	05574	Viking Ind. Inc.	Canoga Park, Cal.	11242	Bay State Electronics Corp.	Waltham, Mass.
00334	Humidial	Colton, Calif.	05503	Icone Electro-Plastics Inc.	Sunnyvale, Cal.	11312	Teledyne Inc., Microwave	
00348	Micron, Co., Inc.	Valley Stream, N. Y.	05616	Cosmo Plastic (c/o Electrical			Div.	Palo Alto, Cal.
00373	Garlock Inc.	Cherry Hill, N. J.		Spec. Co.)	Cleveland, Ohio	11314	National Seal	Downey, Cal.
00656	Aerovox Corp.	New Bedford, Mass.	05624	Harber Colman Co.	Rockford, Ill.	11453	Precision Connector Corp.	Jamaica, N. Y.
00779	Amp. Inc.	Harriaburg, Pa.	05728	Tiffen Optical Co.		11534	Duncan Electronics Inc.	Costa Mesa, Cal.
00781	Aircraft Radio Corp.	Boonton, N. J.			Roslyn Heights, Long Island, N. Y.	11711	General Instrument Corp.,	
00809	Crown, Ltd.	Whitby, Ontario, Canada	05729	Metro-Tel Corp.	Westbury, N. Y.		Semiconductor Division Products	
00815	Northern Engineering		05783	Stewart Engineering Co.	Santa Cruz, Cal.		Group	Newark, N. J.
	Laboratories, Inc.	Burlington, Wis.	05820	Wakefield Engineering Inc.	Wakefield, Mass.	11717	Imperial Electronic, Inc.	Buena Park, Cal.
00853	Sangamo Electric Co.,		06004	Bausch & Lomb Optical		11870	Melabs, Inc.	Palo Alto, Cal.
	Pickens Div.	Pickens, S. C.		Warner Corp., Div. of Stewart	Bridgeport, Conn.	12136	Philadelphia Handle Co.	Camden, N. J.
00866	Goe Engineering Co.	City of Industry, Cal.	06090	Raychem Corp.	Redwood City, Cal.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.	06175	Bausch and Lomb Optical		12574	Gulton Ind. Inc., Data System	
00929	Microlab Inc.	Livingston, N. J.		Co.	Rochester, N. Y.		Div.	Albuquerque, N. M.
01002	General Electric Co.,		06402	E. T. A. Products Co. of		12697	Claroat Mfg. Co.	Dover, N. H.
	Capacitor Dept.	Hudson Falls, N. Y.		America	Chicago, Ill.	12728	Elmar Filter Corp.	W. Haven, Conn.
01009	Alden Products Co.	Brockton, Mass.	06540	Amatom Electronic Hardware		12859	Nippon Electric Co., Ltd.	Tokyo, Japan
01121	Allen Bradley Co.	Milwaukee, Wis.		Co., Inc.	New Rochelle, N. Y.	12881	Metex Electronics Corp.	Clark, N. J.
01255	Litton Industries, Inc.	Beverly Hills, Cal.	06555	Breed Electrical Instrument		12930	Delta Semiconductor Inc.	Newport Beach, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.		Co., Inc.	Penacook, N. H.	12954	Dickson Electronics Corp.	Scottsdale, Arizona
01295	Texas Instruments, Inc.		06666	General Devices Co., Inc.	Indianapolis, Ind.	13019	Airco Supply Co., Inc.	Wichita, Kansas
	Translator Products Div.	Dallas, Texas	06751	Components Inc., Ariz. Div.	Phoenix, Arizona	13061	Wilco Products	Detroit, Mich.
01349	The Alliance Mfg. Co.	Alliance, Ohio	06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.	13103	Thermolloy	Dallas, Texas
01538	Small Parts Inc.	Los Angeles, Cal.	06880	Varian Assoc. Elmar Div.	San Carlos, Cal.	13327	Soliton Devices Inc.	Tappan, N. Y.
01589	Pacific Relays, Inc.	Van Nuys, Cal.	07088	Kelvin Electric Co.	Van Nuys, Cal.	13396	Telefunken (GmbH)	Hanover, Germany
01670	Gudebrod Bros. Silk Co.	New York, N. Y.	07126	Digitran Co.	Pasadena, Cal.	13835	Midland-Wright Div. of	
01930	Amerock Corp.	Rockford, Ill.	07137	Transistor Electronics			Pacific Industries, Inc.	Kansas City, Kansas
01960	Pulse Engineering Co.	Santa Clara, Cal.		Corp.	Minneapolis, Minn.	14099	Sem-Tech	Newbury Park, Cal.
02114	Ferroxcube Corp. of		07138	Westinghouse Electric		14193	Calif. Restator Corp.	Santa Monica, Cal.
	America	Saugerties, N. Y.		Corp., Electronic Tube Div.	Elmira, N. Y.	14298	American Components, Inc.	Conshohocken, Pa.
02116	Wheelock Signals, Inc.	Long Branch, N. J.	07149	Filmohm Corp.	New York, N. Y.	14433	ITT Semiconductor, a Div. of	
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.	07233	Cinch-Graphik Co.	City of Industry, Cal.		Int. Telephone and Telegraph	
02660	Amphenol-Borg Electronics		07256	Silicon Transistor Corp.	Carle Place, N. Y.		Corporation	West Palm Beach, Fla.
	Corp.	Broadview, Ill.	07261	Avnet Corp.	Culver City, Cal.	14493	Hewlett-Packard Company	Loveland, Colo.
02735	Radio Corp. of America, Semi-		07263	Fairchild Camera & Inst. Corp.		14655	Cornell Dublier Electric Corp.	Newark, N. J.
	conductor and Materials			Semiconductor Div.	Mountain View, Cal.	14674	Corning Glass Works	Corning, N. Y.
	Division	Somerville, N. J.	07323	Minnesota Rubber Co.	Minneapolis, Minn.	14762	Electro Cube Inc.	San Gabriel, Cal.
02771	Vocaline Co. of America,		07387	Bircher Corp. The	Monterey Park, Cal.	14960	Williams Mfg. Co.	San Jose, Cal.
	Inc.	Old Saybrook, Conn.	07397	Sylvania Elect. Prod. Inc.		15106	The Spheru Co., Inc.	Little Falls, N. J.
02777	Hopkins Engineering Co.	San Fernando, Cal.		Mt. View Operations	Mountain View, Cal.	15203	Webster Electronics Co.	New York, N. Y.
02875	Hudson Tool & Die	Newark, N. J.	07700	Technical Wire Products		15287	Seiconics Corp.	Northridge, Cal.
03286	Nylon Molding Corp.	Springfield, N. J.		Inc.	Cranford, N. J.	15291	Adjustable Dishing Co.	N. Hollywood, Cal.
03508	G. E. Semiconductor Prod.		07829	Bodine Elect. Co.	Chicago, Ill.	15558	Micron Electronics, Garden City, Long Island, N. Y.	
	Dept.	Syracuse, N. Y.	07910	Continental Device Corp.	Hawthorne, Cal.	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio	07933	Raytheon Mfg. Co., Semi-		15631	Cabletronics	Costa Mesa, Cal.
03797	Elidema Corp.	Compton, Calif.		conductor Div.	Mountain View, Cal.	15772	Twentieth Century Coll	
03818	Parker Seal Co.	Los Angeles, Cal.	07980	Hewlett-Packard Co.			Spring Co.	Santa Clara, Cal.
03877	Transistor Electric Corp.	Wakefield, Mass.		New Jersey Division	Rockaway, N. J.	15801	Fenwal Elect. Inc.	Framingham, Mass.
03888	Pyrofilm Resistor Co.		08145	U. S. Engineering Co.	Los Angeles, Cal.	15818	Amelco Inc.	Mountain View, Cal.
	Inc.	Cedar Knolls, N. J.	08289	Blinn, Delbert Co.	Pumona, Cal.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
03954	Singer Co., Diehl Div.		08358	Burgess Battery Co.		16170	Omni-Spectra Inc.	Detroit, Ill.
	Flinderne Plant	Sumerville, N. J.			Niagara Falls, Ontario, Canada	16352	Computer Dinde Corp.	Lodi, N. J.
04009	Arrow, Hart and Hegeman		08524	Deutsch Fastener Corp.	Los Angeles, Cal.	16554	Electroid Co.	Union, N. J.
	Elect. Co.	Hartford, Conn.	08664	Bristol Co., The	Waterbury, Conn.	16585	Boots Aircraft Mfg. Corp.	Pasadena, Cal.
04013	Tarvus Corp.	Lambertville, N. J.	08717	Sloan Company	Sun Valley, Cal.	16688	Ideal Prec. Meter Co., Inc.	
04062	Arco Electronic Inc.	Great Neck, N. Y.	08718	ITT Cannon Electric Inc.			De Jur Meter Div.	Brooklyn, N. Y.
04217	Essex Wire	Los Angeles, Cal.		Phoenix Div.	Phoenix, Arizona	16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.	08727	National Radio Lab. Inc.	Paramus, N. J.	17109	Thermonetics Inc.	Canoga Park, Cal.
04354	Precision Paper Tube Co.	Wheeling, Ill.	08792	CBS Electronics Semiconductor		17474	Tranex Company	Mountain View, Cal.
04404	Palo Alto Division of Hewlett-			Operations, Div. of CBS Inc.	I well, Mass.	17675	Hamlin Metal Products Corp.	Akron, Ohio
	Packard Co.	Palo Alto, Cal.	08806	General Electric Co.		17745	Angstrom Prec. Inc.	No. Hollywood, Cal.
04651	Sylvania Electric Products,			Miniature Lamp Dept.	Cleveland, Ohio	17856	Siliconix Inc.	Sunnyvale, Cal.
	Microwave Device Div.	Mountain View, Cal.	08884	Mel-Rain	Indianapolis, Ind.	17870	McGraw-Edison Co.	Manchester, N. H.
04673	Dakota Engr. Inc.	Culver City, Cal.	09026	Babcock Relays Div.	Costa Mesa, Cal.	18042	Power Design Pacific Inc.	Palo Alto, Cal.
04713	Motorola Inc. Semiconductor		09097	Electronic Enclosures Inc.	Los Angeles, Calif.	18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
	Prod. Div.	Phoenix, Arizona	09134	Texas Capacitor Co.	Houston, Texas	18324	Signetics Corp.	Sunnyvale, Cal.
04732	Filtron Co., Inc. Western		09145	Tech. Ind. Inc. Atom		18476	Ty-Cap Mfg. Co., Inc.	Holliston, Mass.
	Div.	Culver City, Cal.		Elect.	Burbank, Cal.	18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
04773	Automatic Electric Co.	Northlake, Ill.	09250	Electro Assemblies, Inc.	Chicago, Ill.	18565	Chomertex	Plainville, Mass.
04796	Sequoia Wire Co.	Redwood City, Cal.	09353	C & K Components Inc.	Newton, Mass.	18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
04811	Precision Coil Spring Co.	El Monte, Cal.	09569	Mallory Battery Co. of		18612	Vishay Instruments Inc.	Malvern, Pa.
04870	P. M. Motor Company	Westchester, Ill.		Canada, Ltd.	Toronto, Ontario, Canada	18673	E. I. DuPont and Co., Inc.	Wilmington, Del.
04919	Component Mfg. Service		09795	Pennsylvania Florocarbon	Clifton Heights, Penn.	18911	Durant Mfg. Co.	Milwaukee, Wis.
	Co.	W. Bridgewater, Mass.	09922	Burdick Corp.	Norwalk, Conn.	19315	The Bendix Corp. Navigation &	
05006	Twentieth Century Plastics,		10214	General Transistor Western			Control Div.	Teterboro, N. J.
	Inc.	Los Angeles, Cal.		Corp.	Los Angeles, Cal.	19500	Thomas A. Edison Industries,	
05277	Westinghouse Electric Corp.		10411	Ti-Tal, Inc.	Berkeley, Cal.		Div. of McGraw-Edison	West Orange, N. J.
	Semiconductor Dept.	Youngwood, Pa.	10646	Carborundum Co.	Niagara Falls, N. Y.	19589	Concoa	Baldwin Park, Cal.

Appendix A

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
10644	LIRC Electronics	Horseheads, N. Y.	71482	C. P. Clare & Co.	Chicago, Ill.	78472	Thompson-Bremer & Co.	Chicago, Ill.
10701	Electra Mfg. Co.	Independence, Kansas	71590	Centralab Div. of		78471	Tilley Mfg. Co.	San Francisco, Cal.
20183	General Altronics Corp.	Philadelphia, Pa.		Globe Union Inc.	Milwaukee, Wis.	78488	Stackpole Carbon Co.	St. Marys, Pa.
21226	Excucione, Inc.	Long Island City, N. Y.	71616	Commercial Plastics Co.	Chicago, Ill.	78493	Standard Thomson Corp.	Waltham, Mass.
21355	Fairair Bearing Co., The	New Britain, Conn.	71700	Cornish Wire Co., The	New York, N. Y.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71707	Colo Coil Co., Inc.	Providence, R. I.	78590	Transformer Engineers	San Gabriel, Cal.
23020	General Reed Co.	Metuchen, N. J.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78947	Uemite Co.	Newtonville, Mass.
23042	Texcan Corp.	Indianapolis, Ind.	71785	Cinch Mfg. Co.		79136	Walden Kohinor Inc.	Long Island City, N. Y.
23763	British Radio Electronics Ltd.	Washington, D.C.		Howard B. Jones Div.	Chicago, Ill.	79142	Vreder Root, Inc.	Hartford, Conn.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	71984	Dow Corning Corp.	Midland, Mich.	79251	Wenco Mfg. Co.	Chicago, Ill.
24655	General Radio Co.	West Concord, Mass.	72135	Electro Motive Mfg. Co., Inc.		79727	Continental-Wirt Electronics Corp.	
24681	Memcor Inc., Comp. Div.	Huntington Ind.			Williamstie, Conn.			Philadelphia, Pa.
24685	Gries Reprodicer Corp.	New Rochelle, N. Y.	72619	Dialight Corp.	Brooklyn, N. Y.	79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
24682	Grobert File Co. of America, Inc.	Carlstadt, N. J.	72656	Indiana General Corp.		80031	Mepen Division of Sessions Clock Co.	
24851	Compac, Hollister Co.	Hollister, Cal.		Electronics Div.	Keasby, N. J.			Morrisstown, N. J.
24992	Hamilton Watch Co.	Lancaster, Pa.	72699	General Instrument Corp.		80033	Prescote Corp.	Toledo, Ohio
24840	Hewlett-Packard Co.	Palo Alto, Cal.		Cap Division	Newark, N. J.	80120	Schmitzer Alloy Products Co.	Elizabeth, N. J.
24820	Heyman Mfg. Co.	Kenilworth, N. J.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	80131	Electronic Industries Association	
30817	Instrument Specialties Co., Inc.	Little Falls, N. J.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.		Standard tube or semi-conductor device, any manufacturer.	
31173	G. E. Receiving Tube Dept.	Owensboro, Ky.	72928	Gudeman Co.	Chicago, Ill.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
35434	Leetronm Inc.	Chicago, Ill.	72962	Elastic Stop Nut Corp.	Union, N. J.	80223	United Transformer Corp.	New York, N. Y.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada	72964	Robert M. Hadley Co.	Los Angeles, Cal.	80248	Oxford Electric Corp.	Chicago, Ill.
			72982	Eric Technological Products, Inc.	Erie, Pa.	80294	Bourne Inc.	Riverside, Cal.
36287	Cunningham, W. H. & Hill, Ltd.	Toronto, Ontario, Canada	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	80411	Arco Div. of Robertshaw Controls Co.	
			73076	H. M. Harper Co.	Chicago, Ill.			Columbus, Ohio
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.	73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.	80486	All Star Products Inc.	Defiance, Ohio
39543	Mechanical Industries Prod. Co.	Akron, Ohio	73293	Hughes Products Division of		80509	Avery Label Co.	Monrovia, Cal.
40920	Miniature Precision Bearings, Inc.	Keene, N. H.		Hughes Aircraft Co.	Newport Beach, Cal.	80583	Hammarlund Co., Inc.	Mary Hill, N. C.
40931	Honeywell Inc.	Minneapolis, Minn.	73445	Amperex Elect. Co.	Rockville, L. I., N. Y.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
42190	Muter Co.	Chicago, Ill.	73506	Bradley Semiconductor Corp.		80813	Dimco Gray Co.	Dayton, Ohio
43990	C. A. Norgren Co.	Englewood, Colo.			New Haven, Conn.	81030	International Inst. Inc.	Orange, Conn.
44655	Ohmite Mfg. Co.	Skokie, Ill.	73559	Carling Electric, Inc.	Hartford, Conn.	81073	Grayhill Co.	LaGrange, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.	73586	Circle F Mfg. Co.	Trenton, N. J.	81095	Triad Transformer Corp.	Venice, Cal.
47904	Polaroid Corp.	Cambridge, Mass.	73682	George K. Garrett Co.		81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73734	Federal Screw Products, Inc.	Chicago, Ill.	81349	Military Specification	
49956	Microwave & Power Tube Div.	Waltham, Mass.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	81483	International Rectifier Corp.	El Segundo, Cal.
50900	Rowan Controller Co.	Westminster, Md.	73793	General Industries Co., The	Elyria, Ohio	81541	Airpax Electronics, Inc.	Cambridge, Maryland
52983	HP Co., Med. Elec. Div.	Waltham, Mass.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
54294	Shallcross Mfg. Co.	Selma, N. C.	73899	JFD Electronics Corp.	Brooklyn, N. Y.			Watertown, Mass.
55026	Simpson Electric Co.	Chicago, Ill.	73905	Jennings Radio Mfg. Corp.	San Jose, Cal.	82042	Cartier Precision Electric Co.	Skokie, Ill.
55933	Snootone Corp.	Elmsford, N. Y.	73957	Grove-Pin Corp.	Ridgfield, N. J.	82047	Sperry Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N. J.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.	74276	Signalite Inc.	Neptune, N. J.	82116	Electric Regulator Corp.	Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N. Y.	74455	J. H. Winns, and Sons	Winchester, Mass.	82142	Jeffers Electronics Division of	
56289	Sprague Electric Co.	North Adams, Mass.	74861	Industrial Condenser Corp.	Chicago, Ill.		Speer Carbon Co.	Du Bois, Pa.
58474	Superior Elect. Co.	Bristol, Conn.	74868	R. F. Products Division of		82170	Fairchild Camera & Inst. Corp.	
59446	Telex Corp.	Tulsa, Okla.		Amphenol-Borg Electronic Corp.			Space & Defense Systems Div.	Paramus, N. J.
59730	Thomas & Betts Co.	Elizabeth, N. J.	74970	E. F. Johnson Co.	Waseca, Minn.	82209	Magurie Industries, Inc.	Greenwich, Conn.
60741	Triplet Electrical Inst. Co.	Bluffton, Ohio	75042	International Resistance Co.	Philadelphia, Pa.	82219	Sylvania Electric Prod., Inc.	
61775	Union Switch and Signal Div. of		75263	Keystone Carbon Co., Inc.	St. Marys, Pa.		Electronic Tube Division	Emporium, Pa.
	Westinghouse Air Brake Co.	Pittsburgh, Pa.	75378	CTS Knights, Inc.	Sandwich, Ill.	82376	Astron Corp.	East Newark, Harrison, N. J.
62119	Universal Electric Co.	Owosso, Mich.	75382	Kulka Electric Corp.	Mt. Vernon, N. Y.	82389	Switchcraft, Inc.	Chicago, Ill.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.	82647	Metals & Controls Inc.	
64959	Western Electric Co., Inc.	New York, N. Y.	75915	Littelfuse, Inc.	Des Plaines, Ill.		Spencer Products	Attleboro, Mass.
65092	Weston Inst. Inc. Weston-Newark	Newark, N. J.	76005	Lord Mfg. Co.	Erie, Pa.	82768	Phillips-Advance Control Co.	Joliet, Ill.
66295	Wiltek Mfg. Co.	Chicago, Ill.	76210	C. W. Marwedel	San Francisco, Cal.	82866	Research Products Corp.	Madison, Wis.
66346	Minnesota Mining & Mfg. Co.		76433	General Instrument Corp.		82877	Rolton Mfg. Co., Inc.	Woodstock, N. Y.
				Micamold Division	Newark, N. J.	82893	Vector Electronic Co.	Glendale, Cal.
70276	Allen Mfg. Co.	Hartford, Conn.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.	83058	Carr Fastener Co.	Cambridge, Mass.
70309	Allied Control	New York, N. Y.	76493	J. W. Miller Co.	Los Angeles, Cal.	83086	New Hampshire Ball Bearing, Inc.	Peterborough, N. H.
70318	Allmetal Screw Product Co., Inc.		76530	Cinch-Mynadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.	83125	General Instrument Corp.	
		Garden City, N. Y.					Capacitor Div.	Darlington, S. C.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	76545	Mueller Electric Co.	Cleveland, Ohio	83148	ITT Wire and Cable Div.	Los Angeles, Cal.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	76703	National Union	Newark, N. J.	83186	Victory Eng. Corp.	Springfield, N. J.
70563	Amperite Co., Inc.	Union City, N. J.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.	83298	Bendix Corp., Red Bank Div.	Red Bank, N. J.
70674	ADC Products Inc.	Minneapolis, Minn.	77068	The Bendix Corp.		83315	Hubbell Corp.	Mundelein, Ill.
70903	Belden Mfg. Co.	Chicago, Ill.		Electrodynamics Div.	N. Hollywood, Cal.	83324	Rosan Inc.	Newport Beach, Cal.
70998	Bird Electric Corp.	Cleveland, Ohio	77075	Pacific Metals Co.	San Francisco, Cal.	83330	Smith, Herman H., Inc.	Brooklyn, N. Y.
71002	Birnbach Radio Co.	New York, N. Y.	77221	Phoastan Instrument and Electronic Co.	So. Pasadena, Cal.	83332	Tech Labs	Palisades Park, N. J.
71034	Bliley Electric Co., Inc.	Erie, Pa.	77232	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.	83385	Central Screw Co.	Chicago, Ill.
71041	Boston Gear Works Div. of					83501	Gavitt Wire and Cable Co., Div. of	
	Murray Co. of Texas	Quincy, Mass.	77342	American Machine & Foundry Co.			Amerace Corp.	Brookfield, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio	77630	IRW Electronic Components Div.	Camden, N. J.	83594	Burroughs Corp., Electronic Tube Div.	
71279	Cambridge Thermionics Corp.	Cambridge, Mass.	77638	General Instrument Corp.		83740	Union Carbide Corp., Consumer Prod. Div.	New York, N. Y.
71286	Camloc Fastener Corp.	Paramus, N. J.		Rectifier Division	Brooklyn, N. Y.	83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
71313	Cardwell Condenser Corp.	Lindenhurst, L. I., N. Y.	77764	Resistance Products Co.	Harrisburg, Pa.	83821	Loyd Scruggs Co.	Featus, Mo.
			77969	Rubbercraft Corp. of Calif.	Torrance, Cal.	83942	Aeronautical Inst. & Radio Co.	Lodi, N. J.
71400	Bussmann Mfg. Div. of		78189	Shakeproof Division of		84171	Arco Electronics Inc.	Great Neck, N. Y.
	McGraw-Edison Co.	St. Louis, Mo.		Illinois Tool Works	Elgin, Ill.	84396	A. J. Glesener Co., Inc.	San Francisco, Cal.
71436	Chicago Condenser Corp.	Chicago, Ill.	78277	Sigma	So. Braintree, Mass.	84411	TRW Capacitor Div.	Oxallala, Neb.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.	78283	Signal Indicator Corp.	New York, N. Y.			
71450	CTS Corp.	Elkhart, Ind.	78290	Struthers-Dunn Inc.	Pitman, N. J.			
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.						
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.						

80015-49
Revised: May, 1970

From: Handbook Supplements
H4-1 Dated January 1970

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
94670	Sarkis Tarzian, Inc.	Bloomington, Ind.	91920	Honeywell Inc., Micro Switch Division	Freeport, Ill.	96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
95454	Doonton Molding Company	Doonton, N.J.	91661	Nahm-Bros. Spring Co.	Oakland, Cal.	96256	Thordarson-Meisner Inc.	Mt. Carmel, Ill.
95471	A. B. Boyd Co.	San Francisco, Cal.	92180	Tru-Connector Corp.	Peabody, Mass.	96296	Solar Mfg. Co.	Los Angeles, Cal.
95474	R. M. Baramonte & Co.	San Francisco, Cal.	92367	Elget Optical Co., Inc.	Rochester, N.Y.	96396	Microswitch, Div. of	
95660	Kolled Kords, Inc.	Hamden, Conn.	92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.		Munn-Honeywell	Freeport, Ill.
95911	Seamless Rubber Co.	Chicago, Ill.	92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.	96330	Carlton Screw Co.	Chicago, Ill.
96174	Fafnir Bearing Co.	Los Angeles, Calif.	92966	Hudson Lamp Co.	Kearney, N.J.	96341	Microwave Associates, Inc.	Burlington, Mass.
96197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.	96501	Excel Transformer Co.	Oakland, Cal.
96579	Precision Rubber Products Corp.	Dayton, Ohio	93369	Robbins & Myers Inc.	Pallisades Park, N.J.	96508	Xcelite, Inc.	Orchard Park, N.Y.
96684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.	93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio	96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96928	Seastrom Mfg. Co.	Glendale, Cal.	93632	Waters Mfg. Co.	Culver City, Cal.	96881	Thomson Ind. Inc.	Long Island, N.Y.
97034	Marco Industries	Anaheim, Cal.	93929	G.V. Controls	Livingston, N.J.	97464	Industrial Retaining Ring Co.	Irvington, N.J.
97216	Phileo Corporation (Lansdale Division)	Lansdale, Pa.	94137	General Cable Corp.	Bayonne, N.J.	97539	Automatic & Precision Mfg.	Englewood, N.J.
97473	Western Fibrous Glass Products Co.	San Francisco, Cal.	94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.	97979	Reon Resistor Corp.	Yonkers, N.Y.
97664	Van Waters & Rogers Inc.	San Francisco, Cal.	94148	Scientific Electronics Products, Inc.	Loveland, Colo.	97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
97930	Tower Mfg. Corp.	Providence, R.I.	94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.	98141	R-Tonics, Inc.	Jamaica, N.Y.
98140	Cutler-Hammer, Inc.	Lincoln, Ill.	94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.	98159	Robber Teck, Inc.	Gardena, Cal.
98220	Gould-National Batteries, Inc.	St. Paul, Minn.	94222	South Chester Corp.	Chester, Pa.	98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98698	General Mills, Inc.	Buffalo, N.Y.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.	98278	Microdot, Inc.	So. Pasadena, Cal.
99231	Graybar Electric Co.	Oakland, Cal.	94375	Automatic Metal Products Co.	Brooklyn, N.Y.	98291	Sealectro Corp.	Mamaroneck, N.Y.
99473	G.E. Distributing Corp.	Schenectady, N.Y.	94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.	98376	Zero Mfg. Co.	Burlington, Cal.
99479	Security Co.	Detroit, Mich.	94696	Magnecraft Electric Co.	Chicago, Ill.	98410	Etc. Inc.	Cleveland, Ohio
99665	United Transformer Co.	Chicago, Ill.	95023	George A. Philbrick Researches, Inc.	Boston, Mass.	98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
99930	United Shoe Machinery Corp.	Beverly, Mass.	95146	Alco Elect. Mfg. Co.	Lawrence, Mass.	98734	Pasco Division of Hewlett-Packard Co.	Palo Alto, Cal.
99179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.	95236	Allies Products Corp.	Dania, Fla.	98821	North Hills Electronics, Inc.	San Jose, N.Y.
99365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.	95238	Continental Connector Corp.	Woodside, N.Y.	98978	International Electronic Research Corp.	Burbank, Cal.
99763	United Carr Fastener Corp.	Chicago, Ill.	95263	Leercalt Mfg. Co., Inc.	Long Island, N.Y.	99109	Columbia Technical Corp.	New York, N.Y.
99970	Bearing Engineering Co.	San Francisco, Cal.	95265	National Coil Co.	Sheridan, Wyo.	99313	Varian Associates	Palo Alto, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.	95275	Vitramon, Inc.	Bridgeport, Conn.	99378	Atlee Corp.	Winchester, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.	95348	Gordos Corp.	Bloomfield, N.J.	99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.	95354	Methode Mfg. Co.	Rolling Meadows, Ill.	99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
91418	Radio Materials Co.	Chicago, Ill.	95566	Arnold Engineering Co.	Marengo, Ill.	99800	Delevan Electronics Corp.	East Aurora, N.Y.
91506	Augat Inc.	Attleboro, Mass.	95712	Dage Electric Co., Inc.	Franklin, Ind.	99848	Wilson Corporation	Indianapolis, Ind.
91637	Dale Electronics, Inc.	Columbus, Nebr.	95984	Siemon Mfg. Co.	Wayne, Ill.	99928	Dranson Corp.	Whippany, N.J.
91662	Elco Corp.	Willow Grove, Pa.	95987	Weckesser Co.	Chicago, Ill.	99934	Rembrandt, Inc.	Boston, Mass.
91673	Epiphone Inc.	New York, N.Y.	96057	Microwave Assoc., West, Inc.	Sunnyvale, Cal.	99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.				99957	Technology-Instrument Corp. of California	Newbury Park, Cal.
91827	K F Development Co.	Redwood City, Cal.						
91886	Malco Mfg., Inc.	Chicago, Ill.						

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.	000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado	000QQ	Cooltron	Oakland, Cal.
0000Z	Willow Leather Products Corp.	Newark, N.J.	000MM	Rubber Eng. & Development	Hayward, Cal.	000WW	California Eastern Lab	Burlington, Cal.
000AB	ETA	England	000NN	A "N" D Mfg. Co.	San Jose, Cal.	000YY	S.K. Smith Co.	Los Angeles, Cal.
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.						

BACK DATING MANUAL CHANGES

hp MANUAL BACKDATING CHANGES

MODEL 313A

TRACKING OSCILLATOR

-hp- Part No. 00313-90001

Serials Prefixed: 709-

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
709-00151 and below	1		
709-00225 and below	2 and 1		
945-00280 and below	3, 2, 1		
0962A00500 and below	4, 3, 2, 1		

CHANGE #1 Page 6-2, Figure 6-1. Change the part numbers of the mechanical parts as shown in Figure C-1. All other parts are the same as those listed in Table 6-1.

MP-16 00313-23701
 MP-20 00313-23601
 MP-22 1500-0751

MP-23 5020-0237
 MP-30 5040-0452
 MP-41 5020-0354

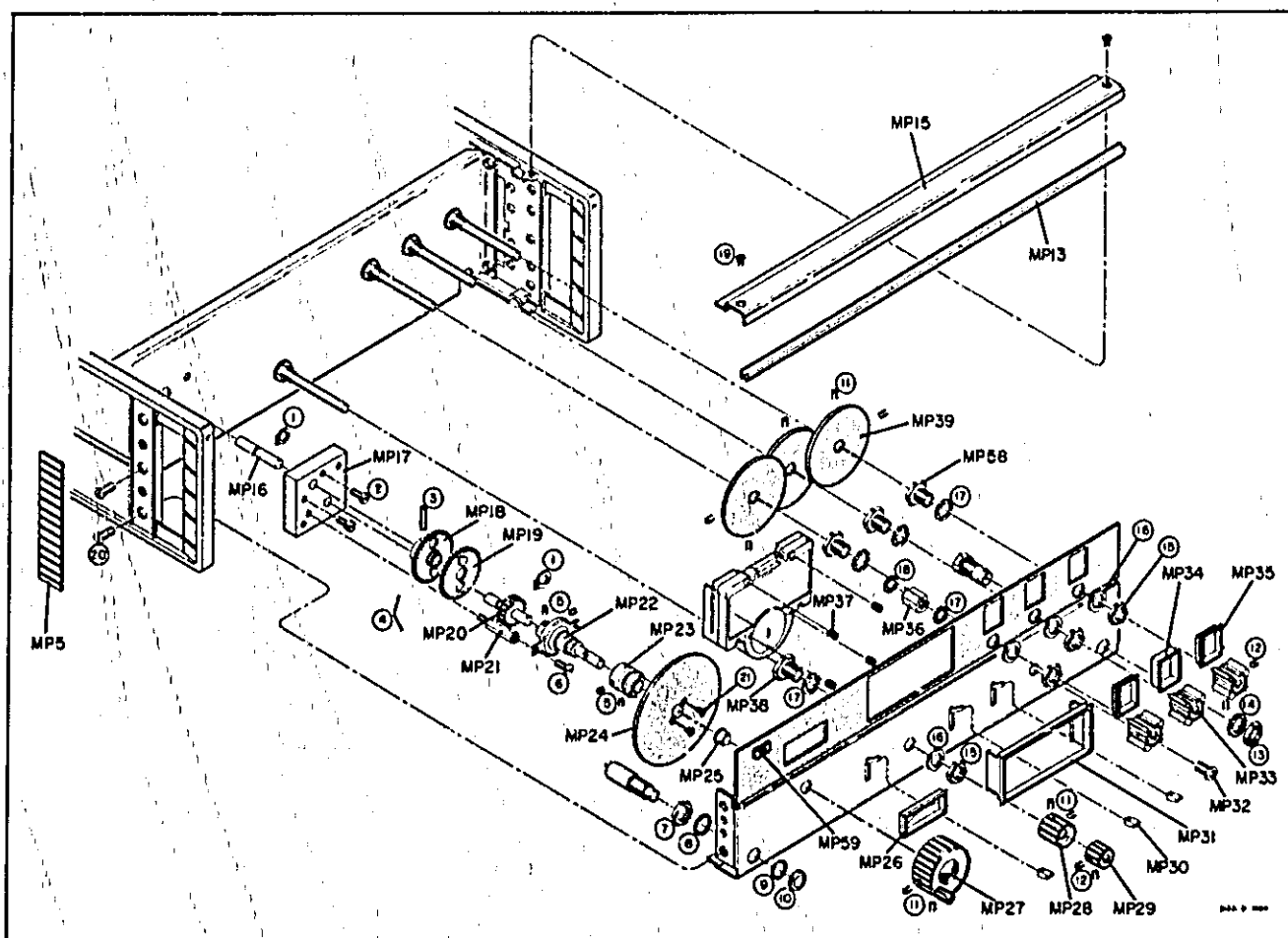


Figure C-1. P/O 313A Mechanical Parts Identification.

CHANGE NO. 2

Page 3-2, Figure 3-1. Change the back panel drawing as in Figure C-2.

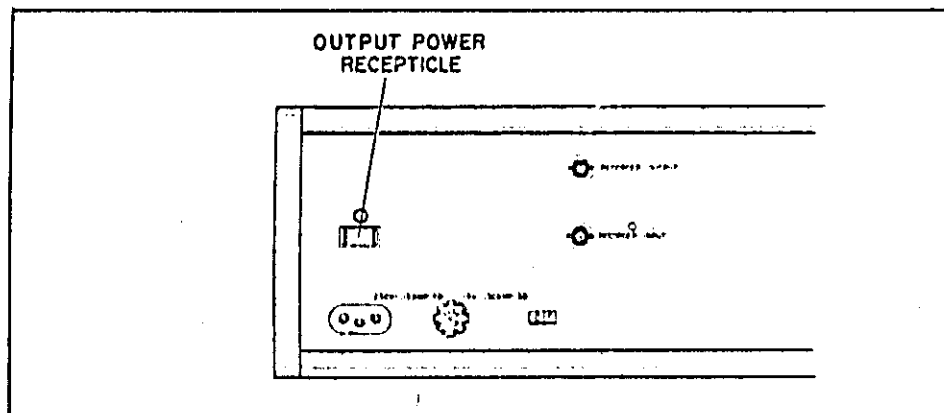


Figure C-2. P/O Back Panel.

Page 6-5, Figure 6-4. Change the Top View drawing as in Figure C-3.

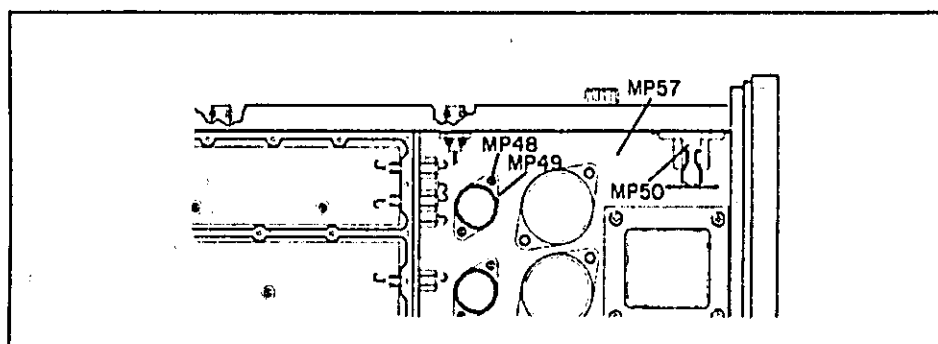


Figure C-3. P/O Top View.

Page 6-15, Table 6-1. Change J1 to 1251-0148. Add J2, 1251-0095; Connector: power ac.

Page 6-16, Table 6-1. Add MP-50, 1251-0156, Connector: nylon receptacle.

Page 6-17. Change W1 to 8120-0078.

Page 7-9/7-10, Figure 7-4. Change the primary ac power supply schematic as in Figure C-4.

CHANGE NO. 3

Page 6-11, Table 6-1. Change A9R3 thru R6 to 0698-0022, 499 Ω . Change A9R7 and A9R8 to 2100-2061, 200 Ω .

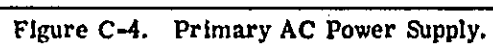
Page 7-13/7-14, Figure 7-6. Change A9R3 thru R6 to 499 Ω . Change A9R7 and A9R8 to 200 Ω .

CHANGE NO. 4

Page 6-10, Table 6-1. Delete A8C40. Change A8Q8 thru Q12 to 1850-0062, TSTR: Ge 2N404.

Page 6-11. Change A8R38 to 0683-5115, 510 Ω .

Page 7-17/7-18, Figure 7-8. Delete A8C40. Change A8R38 to 510.



MANUAL CHANGES



MANUAL CHANGES

MODEL 313A

TRACKING OSCILLATOR

Manual Part No. 00313-90002

New or Revised Item

ERRATA

Change all references in manual concerning 312A to 312B

Page 5-6, Paragraph 5-14, Step l. Delete control setting
RECEIVER MODE AM.

Page 5-10, Figure 5-6, Change A4L1 to A5L1

Page 5-12, Paragraph 5-24, Step c. Change voltage reading to 1.197
 $\pm .001$ V.

Page 5-13, Paragraph 5-26, Step q. Delete Step q concerning 302A

Page 6-6, Table 6-1. Change description of A2Q2 and A2Q4 to
TSTR: Si NPN 2N3094.

Page 6-10, Table 6-1. Change description of ABC33 to C:VAR
Trimmer 1.4 - 9.2 pF.

Page 6-11, Table 6-1. Change A9R9 and A9R11 to R:Fxd Met Fil
 $100 \Omega \pm 1\%$ 1/8 W -hp. Part No. 0757-0401.

Page 6-13, Table 6-1. Change description of A14R10 and A14R11
to R:Fxd Carbon Fil $436 \pm 1/2\%$ 1/4 W.
Change the description of A13R4 to R:Fxd Carbon Fil $26.63 \Omega \pm 1/2\%$ 1/2 W.

Page 6-14, Table 6-1. Change description of A15R3 and A15R4 to
R:Fxd Met Fil $332 \text{ k}\Omega \pm 1\%$ 1/2 W.

Page 6-16, Table 6-1. Change R7 to R8.

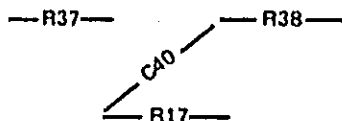
Page 6-17, Table 6-1. Change part number of manual to
00313-90002.
Change part number of kit: 5H Rack Mount to 5060-8740.

Page 7-7/7-8, Figure 7-3. Functional Diagram. Above A3Q11,
change R7B and R7A to R8B and R8A respectively.

Page 7-11/7-12, Figure 7-5. Change the value of the C5 located just
above A12 Local Oscillator schematic from 8-10 pF to 4.8-100 pF.

Page 7-13/7-14, Figure 7-6. Change value of A9R9 and A9R11 to
 100Ω
Change A9C1 to 180 pF.

Page 7-17/7-18, Figure 7-8. Change A8L1 and A8L2 to 2.2 μ H.
Add ABC40 to the component locator as follows:



Page 7-19/7-20, Figure 7-9. Change value of A8C33 to 1.4 - 9.2
pF.
Change value of A3C3 to 39 μ F.

CHANGE NO. 1 for all instruments.

Page 6-3, Table 6-1. Change the part number of MP4 to

2 November 1978

00313-00204.

CHANGE NO. 2 for serial number 0962A00916 and greater.

Page 1-1, Paragraph 1-7. Add sentence "Option 910, Operating and
Service Manual, part number 00313-90002, is an extra manual iden-
tical to the one shipped with the instrument."

CHANGE NO. 3 applies to serial numbers 0962A01116 and greater.

Page 6-3, Figure 6-2. Change MP-4 from -hp- part number
00313-00208 to 00313-00209. Add the following note under the
description.

NOTE

*On instruments with serial numbers 0962A01115 and lower,
the fuseholder must be updated if the rear panel is replaced.*

Page 6-16, Table 6-1. Delete MP47 -hp- part number 2110-0359.
Add MP47 (see Note) -hp- part number 2110-0564, Qty 1. Description:
Fuseholder Body 12A Max; 250 V Max, Mfr. Hewlett-Packard.
MP47 (cont'd) -hp- part number 2110-0565, Qty 1. Description:
Fuseholder Cap Bayonet; 12A, 250 V Max Mfr. Hewlett-Packard.
MP47 (cont'd) -hp- part number 2110-0569, Qty 1. Description:
Fuseholder Nut, Mfr. Hewlett-Packard.

NOTE

*For instruments with serial numbers 0962A01115 and lower,
order -hp- part number 2110-0349 Fuseholder.*

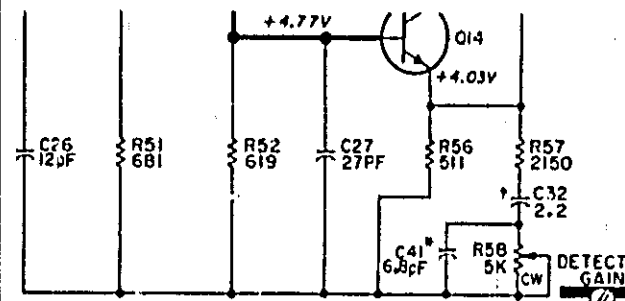
CHANGE NO. 4 applies to serial numbers 0962A01126 and greater

Page 6-9, Table 6-1. Delete the starred value from C26* -hp- part
number 0140-0201.

Page 6-10, Table 6-1. Delete the starred value from C37* -hp- part
number 0160-2198.
Add C41* -hp- part number 0160-2253 Qty 1, Description: C:Fxd
 $6.8 \text{ pF} \pm .25 \text{ pF}$ 500 VDC CER, Mfr. Hewlett-Packard.

Page 7-17/7-18, Figure 7-8. Delete the starred value and (5-28)
from C37*.

Page 7-19/7-20, Figure 7-9. Delete the starred value and (5-29)
from C26*, and change the value from 10 pF to 12 pF.
Add C41* 6.8 pF to the schematic as shown below:



Supplement A for 00313-90002